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Partial history of the development of grain harvesting equipment. 1/

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Harvesters - hand

Sickles

Of all the implements, the history of which it is possible to trace, perhaps there is none more interesting than the reaping machinery. One writer has stated that "Excepting for the plow, probably no mechanical device has had more far-reaching influence in American agriculture than the grain harvester. The harvester, in a very real sense, typifies modern agriculture. Its advent marks the transition from the manual to the machine age of farming." (30, p.14) 2/

In an article by W. L. Braley entitled "Some 4730 years of Grain Drill History" it is stated that "The farmers of ancient Egypt scattered their seed upon the muddy soil left by the receding flood water of the Nile. Flocks of sheep and goats driven over the soil tramped the seed into it."

"Originally, man plucked the wild grain from the stalk to satisfy his immediate hunger. Then, his dawning intelligence sharpened by dire experience, he learned to sow and reap a slender crop, using the most primitive implements. Afterwards larger fields, planted and cultivated by clumsy but still improving tools which were the direct result of this more intelligent handling, gave greater crops. Down through the ages this progress has continued, each new development assuring greater production." (11, p. 30)

1/ It has not been feasible in this report to mention all known individuals and firms contributing to the development of harvesting and threshing apparatus. Hence, in general, reference to concerns now manufacturing such equipment has been omitted - the intention having been to confine the information offered to the pioneers in, and early development of the machines listed. The mention of manufacturers now building harvesting and threshing machinery implies no particular endorsement thereof by the Department.

2/ Numbers in parentheses refer to list of citations at end of article.

With the increased acreage devoted to the growing of grain crops, and the need for harvesting them at the proper time, came the need for implements better adapted to the work to be performed. Naturally the amount of grain a man could luck by hand from the standing stalk was too small to be of much importance other than, as Braley has stated "to satisfy his immediate hunger."

Merritt Finley Miller has stated that "The process of reaping is older than written history." However, according to the same authority, records in the form of remains of ancient implements of flint and bronze have been found in parts of the Old World, which seem to prove that sickles or reaping hooks were probably the first harvesting implements devised. Some of these old-time sickles resemble somewhat our modern sickles in form.

"A tomb at Thebes, probably built 1400 or 1500 B. C., bears a painting which shows the various operations connected with the cultivation and harvesting of grain. After the style of these ancient works of art, the different operations are shown in series in the same painting. Two men are represented with sickle-like implements, cutting the grain somewhat below the heads. They stand side by side and appear to be making the movements simultaneously; behind them a third man, working alone, seems to be gleaning, while others carry the grain to the oxen, which are tramping it out. Other paintings of this time show two distinct modes of reaping. One was to cut low, a handful at a time, and bind into sheaves; the other, which may scarcely be termed reaping, consisted in pulling up the plants by the roots, the heads afterwards being stripped from the stalks by means of a comb or hackle. These ancient Egyptian sickles varied somewhat in form and material. The earliest form consisted of a slightly curved blade fastened at one end to a straight handle." *****"both iron and bronze being used. Later the toothed sickle appeared," *****"the form approaching more nearly that of the modern sickle." (20, p. 7-8)

"The ancient Chinese and Japanese used an implement resembling the sickle and almost the same thing is used by them today". (1902)
 "The Japanese used also another implement for reaping, which they called 'ani-ani.' This cut on the principle of scissors, but was inferior to the reaping hook and was abandoned." *****"The implements of the Jewish people resembled closely those of the Egyptians. The sickle was very common." (22 p.8)

"To Greece the art of agriculture was passed down from the Egyptians. The Romans, too, aided in the development, and considerable advancement was made in the form of implements during Greek and Roman times. Varro describes three modes of cutting the straw as common in Italy. The first was to cut low with a reaping hook a handful at a time; the second, to cut below the heads with a sickle, consisting of a curved stick with a toothed blade attached, and the third, to cut at the middle of the straw." *****

"Among Roman implements we find besides the ordinary form of sickle and reaping hook a small hooked knife resembling a pruning knife, which was used for reaping. It is at this time also that we find the first records of the scythe being used, and although it is not known exactly when it first appeared, the Romans certainly used it, as ancient Roman drawings show. It was crude in form, consisting of a heavy blade on a long straight handle, and was used more for grass than for grain, the sickle remaining preeminently

the reaping implement. Pliny distinguished between the sickle and the scythe, although both were at that time called 'sickles.' The shorter one, which resembled the modern form, he termed the Italian sickle, and the longer one with two handles or hand holds, which corresponded to our present scythe, he called the Gallic sickle."

"After Roman times agriculture began to decline and continued at a very low state" ***** "almost throughout the Middle Ages." ***** "After about ten centuries agriculture began to revive, and with it was brought back the extensive use of the sickle and scythe. Crescenzo in 1548 gives an account of the implements then in use, and among them we find forms of the sickle and scythe as shown by drawings. From this time on both are found in very general use throughout different countries, and both have remained as useful implements up to the present time."

"As already stated, the early Egyptian sickle consisted of a slightly curved blade of iron or bronze, attached to a straight handle, while the toothed form of the implement was a later Egyptian type. Soon a greater bow was given the blade, and it began to look more like the modern form. The smooth sickles were heavier than the serrated forms, and were generally used for cutting near the ground with a chopping motion. The toothed sickle was used to cut the grain nearer the top by means of a drawing motion. As time went on the blade was strengthened by an iron ridge near the back, and finally a steel edge was used. With these improvements both the smooth and serrated sickles reached their most perfect form." (20, p. 9-10)

Scythes.

"The scythe was a later implement than the sickle, and was an evolution from it. It forms what might be termed the second class of reaping appliances, the sickle being first." ***** "This second class made its appearance about the time of the Roman era. The first forms had straight handles, and were very clumsy and heavy, being used only for cutting grass. A Flemish implement known as the Hainault scythe was a form intermediate between the sickle and scythe, and was used for cutting grain. It consisted of a wide blade about two feet in length, with a handle a little over half as long. It was held in the right hand with the forefinger in a leather loop, the blade being kept in a horizontal position by a flat, projecting part of the handle against the wrist." ***** "The grain was gathered by a hook held in the left hand. This was much more efficient than the sickle, but was surpassed by the later forms of the cradle scythe."

"The forms of the scythe varied greatly, particularly in the handle. The blade became lighter as time went on, and the handle passed through various double, forked and iron forms, to the final crooked wooden pattern." (24 p. 10)

That scythes were used in the United States for a considerable period after the invention of mowing machines seems to be proven by the following statement found in the 1860 Census: "Tedious and laborious as its use appears, compared with that of the mowing-machine, it is wonderfully effective in comparison with the rude practice of the Mexican of our day,

who cuts his grain and hay by handfulls with a common knife. It may not be generally known that the most valuable improvement made upon this implement for centuries was by one of the first iron-workers of Massachusetts, more than two hundred years ago, in the very infancy of the colony." ***** "The improvement consisted in making the blade longer and thinner, and in strengthening it at the same time, by welding a square bar of iron to the back, as in the modern scythe, thus materially improving upon the old English scythe then in use, which was short, thick, and heavy like a bush-scythe." (26, p. xxiii)

Cradle scythes or cradles.

Holmes states that "In 1794 a Scotchman invented what was described as a most marvelous and wonderful machine for cutting grain, doing as much in one day as seven men could do with the sickle. This marvelous machine was only the cradle." (13, p. 318)

Miller relates that about the time of the improvement in the blade of the scythe, and the changes in its handle, "A new feature appeared which transformed the scythe into a practical hand reaper. This was the fastening of fingers to the snath to assist in collecting the grain into bundles or gavels. Among the earliest devices of this kind was one which consisted simply of 'two twigs of osier put semicircularly into the holes made in the snath, near the blade, in such a manner that one semicircle intersected the other.' This, projecting upward on the snath helped to carry the grain around the scythe so as to leave it in a bunch. About the same time fingers were introduced - first a single pin inserted in a hole in the snath, later a series of three or four short fingers on a bar which was fastened to the snath in such a way that the fingers extended on a line with the scythe. This form generally had a double snath and a blade much longer than the fingers." ***** "In using it the operator cut toward the grain, leaving the cut stalks standing in a fairly well-gathered bunch against the standing grain." (20, p. 10)

"With the development of agriculture among the American colonists came an improved form of the cradle scythe." ***** "Doubtless all the European types had been brought over by the colonists, and what is termed the 'American cradle' was simply an improvement upon some of these earlier forms. It is impossible to determine just when this implement was invented, but this is of little consequence, as it was doubtless a growth rather than a single invention. It is known to have been in quite common use before the beginning of the nineteenth century, and was rapidly taking the place of the sickle." (20, p. 10)

There appears to be some disagreement among writers as to just when the cradle was introduced into the United States. "The papers of Dr. William Cabell mention the use of 'a scythe and cradle' for reaping grain in Virginia prior to 1760." ***** "Cradling was, according to all accounts, a common method of cutting grain in Virginia and the Middle States during the last decade of the eighteenth century." (24, p. 70)

Reference is made by Miller to statements attributed to "Professor Brewer of Yale in his history of agriculture in the United States, written for the Census report of 1880" in which he "divides the history into four periods, the second of which extends from the time of the Declaration of Independence to the introduction of the cast-iron plow about fifty years later. Of this period he says: 'Many other improved implements came into use during this same fifty years, of which the two most important in connection with American grain growing were the American cradle and the fanning mill for cleaning seed after it was threshed. The sickle was common, though not in universal use at the time of the American Revolution. It was rarely used when the century closed, and had ceased entirely as an implement for cutting other cereals than Indian corn before the close of this period.' These statements fix the introduction of the American cradle as somewhere between 1776 and the close of the century. The American cradle was the culmination of the improvements in hand reaping implements which had begun ages before in the crude stone implements of prehistoric races. Why it should have taken so many centuries to reach its perfect form is a subject for conjecture. Once perfected it spread rapidly to other countries, either in its original form or in a form modified by foreign manufacturers. To-day" (1902) "it is still used in various parts of Europe, and even in America where conditions make the use of the reaping machine impracticable. The sickle still has its place even in the most advanced nations, and it is used almost exclusively in some of the least developed countries." ***** "The scythe also is a necessary implement in the nations most advanced in agricultural methods." (20, p. 10-11)

The cradle, which was a device to be attached to the scythe "for the purpose of gathering the stems and laying the swath down evenly" is described by an English writer as follows: "The cradle is made of three light ash rods fastened to two upright iron rods which are attached to the outer end of the scythe by an upright stem, the whole strengthened by a backstay of iron." (1, p. 373)

The implement known as the American cradle-scythe was perhaps based on the one described by Andrews - the English writer mentioned - as it is probable that the early settlers in this country brought with them many of the tools or implements formerly used by them in the countries from which they migrated.

"The first step forward was the adoption of the scythe; the next of the grain cradle, to assist in gathering the cut grain into windrows or swaths coincident with the mowing. From these two simple implements, or it might more correctly be said from the scythe and hand rake, have developed the numerous machines which are now found in practical operation on the farms of the United States and other countries in mowing, reaping and harvesting the crops." (27, p. 361)

A map is presented on page 140 of the 1919 Yearbook of the United States Department of Agriculture, showing the cutting of wheat with a cradle. According to the map the cradle was at that time commonly used in cutting wheat in parts of New England, Virginia and West Virginia, Kentucky, Tennessee and North Carolina. The legend accompanying the map,

however, states that "As a rule, this method is used only when the wheat fields are too small, or when there are too many obstacles for the economical use of the binder." (9, p. 140)

Carl R. Woodward, writing of the early days stated that "Rye, wheat and buckwheat were cut with a sickle, but oats, like grass, fell under the scythe. The sickles used were long and narrow, their sharp edges having close teeth on the inner side. This manner of harvesting continued until after the Revolution, when farmers were delighted by the appearance of the cradle, which improvement created as much interest as has, in modern times, the introduction of the reaper." (31, p.16)

"A new cradle, lighter and more effective, was designed, which was known as Vaughan's cradle, after the inventor, Charles Vaughan, of Hallowell, Maine. It was called also the Scotch bow or Scotch cradle." The authors continued as follows: - "A contributor to the Maine Farmer (v. V, (1837) p. 178) wrote: - 'It is much lighter, more easily made and kept in repair, than the common clumsy cradle, which is burdensome for a man to bear on his shoulder, and which to swing all day requires great strength and effort. To reap half an acre of grain is considered a fair day's work; and to do this well, a man must have had some experience in the business. To use the old-fashioned cradle, requires so much dexterity, that with us, it is almost a trade by itself; and a cradler demands and receives two or three times as much pay as a common laborer. With the improved cradle, after a little use, a good mower will be able to reap as much ground in a day as he could mow, and to leave the grain in good order to bind up. It is no inconsiderable advantage to cut the straw close to the ground:" (10, p. 207-208)

A brief comparison of the rates of doing work with the various types of hand harvesting implements may be of interest as indicating to some extent the progress made in their invention, and their importance in harvesting the grass and small grains grown in this country in the early days.

There appears to have been some differences in opinion among the writers who have given estimates as to what constituted a fair day's work with the crude tools in use many years ago.

"The methods employed and the implements used in harvesting, threshing and cleaning grain were but little advanced over those of the ancient Israelites. Wheat, and sometimes other small grains, was still reaped with a sickle." ***** "Grass and occasionally grain as well was cut with a scythe. An important innovation in the Middle Colonies in the latter part of the century, which was not known in New England until after 1800, was the grain cradle. 'This consisted of a broad scythe, with a light frame of four wooden fingers attached corresponding in shape and nearly of the same length. With this the grain could be cut and at the same time gathered, and by a dextrous turn to the left the reaper could throw it in a swath, ready to be raked and bound into sheaves.' With such primitive tools harvesting was a slow business. Richard Peters estimated that a reaper or mower would not average more than three-fourths of an acre a day, and in heavy grain or grass not more than half an acre." (Possibly this refers to the use of

a sickle or scythe.) "In cradling grain 2 or 2 1/2 acres are considered a day's work." Tilton, is quoted as having stated that "A man can cut an acre of wheat with a sickle in a day; cradle four times as much oats or barley; and mow an acre of green grass with a naked scythe." (10, p. 125-126)

According to the Thirteenth Annual Report of the U. S. Commissioner of Labor (1898) to harvest an acre of wheat yielding 20 bushels per acre about 1830 required 20 hours of man labor in reaping, binding and shocking the grain, when the sickle was used for cutting it. (28, p. 470-471)

With a cradle approximately 10 man hours were required for performing the same tasks. About 1896 one man driving three horses attached to a binder could cut an acre of wheat averaging 20 bushels per acre, in about 42 minutes. In 1930, according to the same authority, an acre of 20-bushel wheat could be cut and threshed with a 12-foot combined harvester and thresher in about 25 to 30 minutes, with a 2-man crew. (14, p. 3)

"Two acres was considered a fair day's work for a man in cradling wheat, and another hand would be kept busy binding and shocking the wheat cut by one cradler." (35, p. 1)

The combined harvester-thresher is a great labor-and time-saver over the binder and threshing machine.

Mechanical Harvesting Machines

Although since the advent of the Marsh harvester the term "harvester" has been applied very largely to the particular type of machines which carry binders of some kind, either men to bind by hand, or automatic binders, Ardrey holds that this use of the word is "arbitrary and narrow." It is believed that the term should be used in its broadest sense, and include such machines as headers, reapers and combined harvester-threshers, all of which are designed for the reaping of grain crops. (8, p. 53)

Miller asserts that "The term 'harvester' may, in its broadest sense, be applied to the modern self-binder as well as to the header of the Western plains and of Australia. Long before the self-rake had reached perfection, invention had been going on in both these directions, and various forms of machines had been devised. Even before a practical cutting apparatus had been produced efforts were being put forth toward making a device for heading and threshing grain, and also to discover some mode of forming the cut grain into sheaves." (20, p. 33)

In this article an attempt has been made to present the various inventions for grain harvesting as nearly as possible in chronological order, and also to group the several inventions under specific headings where this could be done, although at times there is some overlapping.

As distinguished from hand implements (which were not, strictly speaking, machines) used in the early days, and in this country through the early decades of the nineteenth century, the following data will relate as nearly as it has been possible to separate them, to the three classes of grain harvesting machines above mentioned, and to binders.

Inasmuch as some of the early machines in this country were designed to cut both grain and grass it seems proper to include under the term "harvesters" the description of some of the early machines which finally became better known as mowers, although no effort has been made to include all those machines which were designed primarily as grass cutters.

Miller comments on the extended period (centuries) during which the only reaping implements known were the sickle and the scythe. He states that "Almost nothing was done toward constructing a reaping machine until near the close of the eighteenth century, and almost one-third of the nineteenth century had passed before a practical machine was constructed. For thousands of years the sickle had been the only means of cutting grain, with the exception of the scythe, which came into use in the later centuries."***** "There were a few attempts made toward constructing a reaping machine even during this long period when the sickle held sway, but they were rude affairs and were of little consequence." (20, p. 11)

Headers

According to Miller "The first mention in history of a reaping machine is one described by Pliny during the first century, as in use in the fields of Gaul," ***** "It was not a true reaping machine, but a 'header' consisting of a large hollow frame, mounted on two wheels, and set with teeth along its front edge. These teeth caught the heads and tore them off, after which they were raked into the box by an attendant. This machine, like all the early forms, was pushed by an animal yoked behind it. Palladius gives a similar account of the machine, and adds that 'the driver can set the teeth high or low, and that a few goings over the fields will clearly reap it if the ground is smooth.' As this mention by Palladius was made in the fourth century it is probable that some form of the machine was in use for many years, but nothing very practical came of it, and it seems to have been forgotten for centuries." (20, p. 12)

Headers have been of two distinct forms. In one type the heads were stripped off the standing grain, as in the Gallic header just described, and the other type, in which the heads are cut off, as in the modern harvester-thresher. Even before the combine was introduced into the Great Plains headers were used in that area to harvest wheat, which was later threshed with an ordinary threshing machine.

Miller is authority for the statement that "Headers formed the first type of cutters or severers, the revolving knife the second, and the reciprocating knife the third and most successful type. The revolving principle was naturally suggested by the notion of the sickle or scythe, linked with the revolving of a wheel." (20, p. 13)

In the opinion of Ardrey the Gallic header "has not received the attention it deserves." ***** He declares that "It was the prototype of all headers and strippers. Its distinctive features are shown in several modern inventions in this class, and the Australian strippers of today" (1894) "less their threshing attachments, are mere copies." (8, p. 53)

Ardrey continues - "The discussion of this machine in England a hundred years ago, growing out of the publication of the descriptions given by both Pliny and Palladius, and instigated also by a premium offered by the Society for the Encouragement of Arts, Manufactures and Commerce, brought out in 1786 the machine for 'rippling corn' (grain) of William Pitt, of Pondeford. It was an attempted improvement on the ancient one just described. The 'rippling cylinder' - the first suggestion of a reel - took off and delivered the heads into a box behind the strippers." ***** "So here, after nearly 1,800 years, we have the second header, according to the records." (8, p. 53-54)

"A man by the name of Capel Lofft, of Britain, first suggested the idea of a reaping machine, in 1785, probably as a result of the proposal made in 1780, by the Society of Arts, for a premium to be given the author of such an invention. This machine was probably never built, but existed only in the model or on paper. Little is known of its construction, and it is of interest only as being the first one suggested." (20, p. 12)

On this side of the Atlantic a header was invented early in the nineteenth century, according to Carl R. Woodward, who is authority for the following statement:- On "November 2, 1825 James Ten Eyck, of Somerset County" (New Jersey) "patented a machine having a horizontal cylinder with spiral knives cutting against straight edges, apparently somewhat on the principle of the modern lawn mower. Below the revolving cylinder were three or five fingers nine inches long." (30, p. 14)

The Ten Eyck invention "was in effect a 'header,' thus anticipating the most recent stage of the evolution of the harvester." ***** "The 'scythe cylinder' was revolved by means of a rawhide band connected with the traction wheels." Mr. Ten Eyck elaborated on the adaptability of his machine as follows:- "This machine may be made of any size to the fancy of the owner, from three or less to twelve feet, which is sufficient for a horse, and from two to four feet for one hand, and from four to eight feet for two men to work by hand." The machine was designed to cut and gather "wheat, rye, oats, barley, and the ears of timothy, or any other grain whose ears grow on the end of the stalk." Because of its rapid motion it was suitable for use in "gathering buckwheat and clover when" (those crops were) "thin on the ground." When a horse was used for power the machine was capable of cutting "from 10 to 15 acres per day." Cylinders of varying sizes were provided for different crops - wheat and rye calling for a cylinder 4 1/2 feet in diameter, while a 3-foot cylinder was sufficient for oats and flax, and a 2-foot cylinder could be used in buckwheat, grass and clover. Despite the inventor's optimism regarding this machine as disclosed in papers left by him there is no evidence that it ever came into general use. Woodward observes, however, that it "deserves recognition as exemplifying the progressive search for a workable harvesting machine." ***** "It is significant further in anticipating two modern machines - the great 'header' of the Wheat Belt, and the modern lawn mower." (32, p. 16)

"D. Ashmore and J. Peck, of Tennessee, September 18, 1835, patented a header with cutters like those of the old Gallic machine; but they added fingers (not cutting) projecting beyond the cutters, 'the better to guide the heads to the knives,' and also a reel, or 'open cylinder' carrying knives which in revolving came nearly into contact with the row of fixed lance-shaped knives or strippers. It resembled somewhat the first modern harvesting machine - that of William Pitt, in 1786, before described. They claimed 'the principle of the governor of the rudder to give direction to the machine.'"***** This machine was "operated from behind." (8, p. 54)

Another header described by Ardrey was invented by George Esterly, of Wisconsin, for which he obtained a patent October 2, 1844. "'The box which receives the grain is supported on wheels, and is provided with a permanent knife in front, and a rotating reel with beaters, which carry the heads of grain up against the permanent knife to cut them off.' By a lever the attendant adjusted the cutter and reel to the varying height of the grain. Esterly's machine was manufactured on a considerable scale, and did good work." ***** "Afterward he added a canvas apron to carry the heads back, and another to deliver to the side and into wagons; besides making improvements in other respects. It was a leading machine back in the 'forties.'" (8, p. 56)

"March 27, 1849, Jonathan Haines, of Illinois, patented his celebrated header, known throughout the West generally" ***** "as 'Haines Illinois Harvester.' Large numbers of them" ***** were "built, and they were thoroughly practical heading harvesters. His claim was on 'suspending the frame which carries the conveyor reel and cutter, upon the axles of the wheels' ***** 'when the frame thus suspended is hinged to the tongue, and rendered capable of being turned upon its bearings, by means of a lever, for the purpose of elevating and depressing the cutter as herein set forth.' It cut a very wide swath in the ordinary manner, and harvested rapidly when run to its capacity. The patent was subsequently re-issued so as to cover his devices better." (8, p. 56)

A patent seems to have been issued to "J. R. and C. N. Mayberry, of Illinois, November 19, 1861, for improvements in balancing, equalization of draft, and raising and lowering their header. September 16, 1862, Royal Hance, of Illinois, patented a header on which the conveyor was located in front of the drive wheel, and the horses were attached to and drew from the front." (8, p. 60-61)

"C. Denton, of Illinois, October 9, 1866, patented his header, the improvements being chiefly upon devices for raising and lowering the cutting apparatus, and in attaching the spout, etc." ***** Another patent was issued to this patentee on "June 30, 1868." This patent was "on spout and arrangement for driving sickles for his header." (8, p. 61)

Reapers - (Foreign)

Ardrey, is authority for the statement that "There is no record of any machine constructed to reap grain otherwise than by hand until about the close of the last" (18th) "century. There was unquestionably stripping harvester used by the Gauls early in the Christian era, but" ***** "it

was not properly a reaper." (8, p. 41) In the foregoing pages the Gallic machine referred to has been designated and described as a header.

During the latter part of the 18th and early years of the 19th centuries several attempts were made to produce labor-saving and time-saving machines for harvesting grain. Space does not permit describing each in detail, but a few of the important ones will be mentioned.

"In 1793, two men by the name of Cartwright each invented a machine for mowing and reaping, but descriptions of these are wanting. The reverse is the case with a machine invented in 1799, the name of the inventor being wanting, but the description being known. It is described as cutting the grain close to the ground by a number of knives on a wheel that revolved upon a circular piece of sheet iron, to which were riveted a number of steel points. These points were pushed into the standing grain and served not only to hold it but acted also as one-half of a pair of shears (the revolving knives being the other) by which cutting was effected. The grain, falling upon a platform, was swept by a rod, fixed to the axle of the wheel, off the platform and laid in the form of a sheaf out of the way of the next course of the machine. Nothing more is heard of the machine, however, and if it ever advanced beyond the model it was probably a failure. It possessed some valuable features, however, if properly constructed, and seemed far in advance of the ideas of that time. The revolving knife principle which it embraced was a favorite among the early inventors."

"The first machine of importance working on the revolving-knife plan was that of Joseph Boyce, of London, also built in 1799, which was the first English machine patented. It had a vertical shaft, to which were fastened a number of blades. This shaft was made to revolve by power transmitted from the wheels on which the machine was mounted. It had no contrivance for gathering the grain to the knives, or for laying the cut grain in a swath or in gavels."

In 1800 "A man by the name of Mears attempted to adopt shears as a cutting apparatus on a machine which he worked by hand, but it was not successful, since neither the shearing apparatus nor the mode of applying the power was practical. During the next four years nothing of importance appeared, although a few attempts were made both in Europe and in the United States. Two machines by an anonymous Frenchman are mentioned, but details concerning them are meager. We only know that 'one was on the rectilinear motion, advancing only, and the other on the circular motion, continuous and advancing.' A few scattering inventions were made in the United States in the early part of the century, but they were unimportant."

"The next important invention was by Plucknet, of Deptford," (England) "in the year 1806. It consisted merely of a rotating circular plate, toothed at the edges, entirely destitute of any gathering apparatus, so that, if it cut at all, it would leave the grain in a tangled mass. It gained no reputation, and was speedily abandoned." (24, p. 12-13)

Ardrey, referring to the 1805 machine of Plucknet calls it a "crude thing," but states that it "had gatherers, or outside and inside dividers," which statement disagrees with that of Miller that it was "entirely destitute of any gathering apparatus." Ardrey further asserts that "In 1807 Mr. Plucknett had a machine, which, as described, was drawn from the front and side, and a driver's seat is shown thereon." (8, p. 42)

In 1806 "Gladstone invented a machine with a circular revolving cutter having a smooth edge. It was supported on a carriage frame with two main wheels and a pair of long shafts projecting forward and to one side, so that the horse walked beside the grain, pulling the machine, this being the first machine to be drawn. The circular cutter was overlapped by a sort of shield, armed with pointed projections which served to gather the grain and hold it until cut. It had outside and inside dividers, and a complicated gathering apparatus was used, consisting of a platform above the rotating knife, on which the grain fell and from which it was swept by a rake, leaving it in small bunches. It was very ingenious, but failed on account of the complicated gatherer."

"In 1808 Mr. Salmon of Woburn, brought out a machine containing some new features, the most important of which was the cutter used. This consisted of a row of vibrating knives acting over stationary blades, and was the first vibrating cutter. It was the first to combine the reciprocating and advancing motion, and was the first hint at the third class of cutters, or those with reciprocating knife. The plan of delivery was somewhat in advance of the day, consisting of a vertically working rake, driven by a crank in the rear of the machine. By this means the grain was raked from the platform, which was placed just behind the cutter. The machine promised much, but owing to certain defects it was a failure and was abandoned." ***** "Up to this time none of the machines had approached perfection, and few had been operated beyond a mere trial. Little attention was paid to them by practical farmers, and they constituted but a small factor in agricultural operations."

"Two other machines were brought out," (in 1811) "both by Northumbrians, John Common and Donald Curming. The latter's machine was patented, and was a novel affair. The cutter 'consisted of a series of revolving disks placed on two flat bearers, the latter forming an angle whose point faced the grain. As the machine moved forward the grain was cut between the revolving disks. A series of 'hold fasts' projected before the cutters to lead the grain up to them. The grain was gathered by revolving vanes or drums and carried off to each side of the machine by endless webs.' This machine had some pretensions to efficiency, and fore-shadowed some of the appliances of modern machines, but it was too complicated and visionary to be practical, and was soon forgotten. Common's first machine was of little value, but the next year he brought out another, with an endless web on two rollers which gave a side delivery, while his knife had some resemblance to the famous Hussey pattern of the Western Continent. It was not patented and was soon forgotten." (20, p. 13-15)

The machine invented by James Dobbs, a dramatist, in 1814 appears to be the next attempt to build a reaping machine, so far as is disclosed by the records. Dobbs "worked the machine on the stage upon a small field artificially planted with wheat. The cutter was circular, with a toothed edge. The body of the machine resembled a wheelbarrow, and was pushed forward in the same way, the drive wheel being placed between the handles. It had quite a complicated system of rollers and dividers to lead the grain to the cutter, but it was not practical, and was probably remembered only because of the manner in which it was introduced."

"In 1815 a man named Scott, of Ormiston, produced a machine with a rotating cutter consisting of a wheel carrying 16 small-toothed sickles and

having projecting prongs in front like Gladstone's. The gatherer consisted of an inverted conical drum something like Smith's, but with 24 jointed prongs projecting from it to act as collectors or rakes in carrying the grain from the cutter to the ground. It had several minor contrivances, but did not work beyond a trial."

"Nothing further of importance came out until 1820, when Mann, of Roby, constructed his model of a reaping machine. This attracted much attention but the full-sized machine was not constructed until 1822, and, when it did appear, it was so complicated that success was doubtful. He continued to work on the machine, however, until 1832, at which time it could be described as follows: A wheel frame bearing a polygonal revolving cutter, with a series of revolving rakes for carrying the grain to the swath, and an apparatus for cleaning the rakes. The machine was drawn, and the line of draft, although applied in front, was parallel to the line of motion. The special feature was the twelve-sided cutter, which was expected to be more efficient than a circular one. It did not come up to expectation, however, and although used to some extent in the field, it never came into general use."

A noted invention in the line of reapers was that of Henry Ogle, "whose machine" ***** "came out in 1822," ***** (Some writers claim, however, that the correct date for this invention was 1820 instead of 1822. "The machine itself never became popular, but the principle of the cutter together with the reel which he constructed is found incorporated in every successful reaper since that time. He constructed a model of a machine in 1822, but not being a workman himself, he submitted the making of a full-sized machine to Thomas and Joseph Brown, of Alnwick, England, who afterwards helped him in his design. Hence the machine is sometimes spoken of as the Ogle and Brown machine. It resembled the skeleton of a cart with wheels and shafts, the horse walking ahead beside the standing grain and the cutting apparatus extending to the right side. This cutter consisted of a frame whose front bar was of iron armed with rows of teeth 3 inches long projecting forward. Directly under these lay the cutter, a straight-edged knife. There was a reel resembling the modern form, which pushed the grain backward onto a platform situated behind the cutter. This platform if hinged could be used as a dropper; if fixed, the grain could be raked off in gavels." ***** "From the position of the lever a seat was evidently provided for the operator."

"Here, then, we have the foreshadowing of the future reaper - the reciprocating knife over stationary fingers, the reel, the platform, and dividers. It was drawn from the front and side, and was borne on two wheels, as are all modern machines. To be sure the dividers and platform had been used before, while Salmon had made a kind of reciprocating knife in 1807; yet the latter was very unlike this, acting more on the principle of the scissors. Ogle should be given the credit for the first reciprocating knife combined with stationary fingers, together with a very happy combination of other lasting features of the reaper, and while the machine never became a great success, owing in a great measure to the disfavor in which reaping machines were held by laborers, and to the threats made upon the manufacturer, yet it was the embryo of the modern reaper and holds a prominent place in the development of these machines."

"Up to this time no machine had been in any great degree successful in the field. To be sure, some of them, such as Smith's and Kerr's had been used to some extent, but the greater number had not survived a few tests." ***** "A machine which was brought into use in considerable numbers, and which was used for some time in the fields of England and Scotland," ***** "was invented by Patrick Bell, of Carmyllie, Forfarshire, in 1826, and put in the field in the following year." ***** "After about two years' experimenting he brought out what has since been known as the Bell reaper." ***** "It consisted of a wooden frame mounted on wheels, with a pole extending backward, to which the horses were attached. The cutting apparatus was on a shearing or clipping principle and consisted of thirteen stationary blades about 15 inches long and about 4 inches wide at the wider or base end, above which were placed twelve movable blades of about the same size, fastened on pivots so as to be moved back and forth over the stationary ones below, thus giving a motion like to that of so many pairs of shears. The power was communicated to the movable blades by connecting their rear ends with a sliding bar, made to move by an oscillating rod connected with a worm flange on a revolving shaft. A canvas moving on rollers and sloping to the cutters carried the cut grain to one side, where it was left in a continuous, even swath. The machine was also provided with dividers, and with a reel much like the modern forms."

"This machine, although built on the wrong principle to ever become a great success, was used for many years in various parts of England, or until the introduction of" ***** "machines springing from the inventions of Hussey and McCormick." ***** "With the introduction of these American machines there entered a foreign element into English invention, and from this time on the machines of importance were various improvements upon three types - Bell's, Hussey's and McCormick's. Of course there were sundry other inventions which did not include the principles of these machines, but they were of little consequence in the real development of the reaper. Up to 1831 there had been 2 French, 1 German, 33 English and 22 American inventions recorded, with a few unimportant attempts in this line from various other sources." ***** "Before considering those machines which combine both English and American elements, it would be well to notice what should be conceded to English inventors in this interesting development." ***** "For the reciprocating knife over stationary fingers, and for the revolving wheel we are undoubtedly indebted to Henry Ogle, whose unique machine contained so many elements of the modern reaper. For the platform on which the grain falls we must look first to Gladstone, who in 1806 used such a contrivance on his machine. The machine failed, but the principle of the platform has survived. As to a grain board or divider it is somewhat uncertain who should be given the credit of advancing this idea." ***** "Dobbs, in 1814, had a 'complicated process of rollers and dividers to lead the corn to the cutter,' while Gladstone's machine, with its stationary fingers above the revolving knife, and Salmon's with its clipping cutter, undoubtedly had something of this sort. Gladstone's machine contains the first hint toward a self-rake, while Salmon repeated it in a different form. Cummings' machine of 1811 contained a reel. Ogle must be credited with the first dropper in 1822, and Gladstone with the first side-draft machine in 1806."

"Of the machines in which both English and American principles were blended there are some that are of special importance, but few that aid" *****
"materially in tracing the true development of the reaper."

"The Hussey machine, introduced into England near the middle of the past century, consisted of a low frame mounted on two wheels, the larger being the drive wheel which transmitted the motion to a vibrating bar, bearing pointed blades or sections working through slots in iron fingers projecting forward on the front of the cutter bar. Behind the cutter was placed a platform to receive the cut grain, from which it was raked by a man riding on the machine. The machine was exceedingly simple, and was without reel or any complicated apparatus."

"The McCormick machine, introduced about the same time as the Hussey, was somewhat more complicated, but had the same principle of a vibrating knife, excepting that in this case the knife had a serrated edge with only a wavy outline instead of pointed sections as in Hussey's. The fingers also differed somewhat from the Hussey type, and a reel was added to make the cutter more effective, but no place was provided on the machine for the raker, who was compelled to walk. Both machines were drawn, the horses being in front of the machine and beside the standing grain."

"With these brief descriptions it is possible to glance with more intelligence at some of the modifications brought out by the English inventors. It should be noted here that many of the machines constructed at this time combined both grass cutting and reaping appliances, and were used for both mowing and reaping. Thus the mower was born in combination with the reaper, and it was only in later forms that it became a separate machine."

"It was at the Great Exhibition of 1851" ***** "that a widespread interest became manifest in regard to reaping machinery. This was occasioned chiefly by the appearance of the Hussey and McCormick machines which were entered in competition at this time. In addition to these, a machine was contributed by a Mr. Garrett, which, however, was the invention of a man by the name of Tolemache. It possessed the advantage of a side delivery, and the horses were yoked one before the other. Numerous models were exhibited but these were the three of importance."

"The knife in McCormick's machine had a serrated edge with numerous obtuse blades riveted into the bar, forming very obtuse angles, so that it acted as a saw, requiring the aid of a reel to hold the grain against it. Hussey's on the other hand, had pointed knives, which formed very acute angles with the guards, and the cutting was more in the nature of clipping or chopping. It was more likely to choke than McCormick's, and one of the chief objections to it was that it required too fast a pace of the horses to keep it cutting well. Garrett's was inferior to both these machines, and in the trial McCormick won the medal. Not being satisfied with this Hussey asked for another trial, which took place sometime afterwards and in which his machine carried off the honors over McCormick's."

"Hussey's machine for some time before this Exhibition had been manufactured by Dray & Co., of London, and was called Dray's Hussey, while in 1850 Richard Brooman took out an English patent for McCormick's machine. During the fifteen years following this Exhibition, the progress in invention was marvelous both in the United States and in England."

"For purposes of discussion these English machines may be divided into two classes: (1) Those having a mechanical delivery, and (2) those having a manual delivery. In the first class, Crosskill's improvement of Bell's machine in 1852 was one of the most important. The improvement consisted in the substitution of McCormick's serrated, vibrating knife in place of the scissors form of cutter, and in substituting for the revolving canvas a series of endless bands of vulcanized rubber, fitted with projecting pieces of wood. Burgess and Key made an improvement on the McCormick by placing on it a swath delivery apparatus, in the form of a series of Archimedian screws, which laid the grain in an even swath. It also contained a few minor improvements such as revolving cone which acted as a divider, and the height of cut could be regulated while the machine was in motion. Another important machine was Lord Kinnaird's, which had McCormick's cutting apparatus with the addition of his own patented delivery apparatus, consisting of endless bands over a smooth surface, being similar to that of Bell's. The horses walked at the side, one before the other, the rear one being hitched to the shafts. It was a simple machine of light draft."

"McCormick's English machine in 1861 differed from the preceding in delivering the grain in gavels rather than in the swath. It was virtually the American self-rake" (which will be described later) "and which had by this time become very common in America. It had a series of revolving vanes, one of which was made to sweep the grain from the platform out of the way of the next round. It was manufactured by Burgess and Key."

"A machine introduced by Samuelson was similar to the McCormick in having a self-acting sheaf delivery. His 1863 model was an improvement over the one of the year before, having four (formerly six) rakes attached to an upright shaft in such a manner as to admit of a free ascending, descending, and horizontal motion. Two of these rakes were dummies, while the other two both gathered the grain and raked it from the platform, which was quadrant shaped, so that the grain was left to one side as it was by McCormick's machine. The height of the cut was easily regulated."

"In 1862 Kemp, Murray and Nicholson introduced a machine in which a self-delivery apparatus was applied to an 'improved Hussey'. It consisted of a self-acting tipping platform and a revolving reel with four arms, one of which was longer than the others. At the time when the long arms came in contact with the grain the tipping board fell, leaving a well-formed sheaf at regular intervals. A single attendant was needed to guide and control the machine, and the size of sheaf could be regulated at will. This concludes the list of important self-delivery machines up to 1864."

"Of the manual forms which constitute the second class, the following may be mentioned: Picksley and Sims's machine, which was the patent of Mr. Bartlett, and which was quite an important machine of this class. It had two wheels with a guard or castor wheel ahead to prevent the cutter bar from coming in contact with the ground. The cutter was on the clipping principle, and was attached to a vertical vibrating bar allowing a very free motion. The grain fell upon a platform with a spring which gave way with a certain weight, thus tipping and dropping the sheaf with the aid of the raker, who sat on the machine. It was really a combination of the manual and self-delivery types."

"Gardner and Lindsay's improvement of the Hussey was a very popular machine in Scotland, and was among the first of the improved Hussey's. The machine had two wheels and a castor in front. The cutter bar was hinged and folded, this being the first record we have of such a bar among English models."

"Kemp, Murray and Nicholson also made an improved Hussey, the improvement consisting of an increased size both in the driving wheel and in the off-side traveling wheel. The speed of the knife was also increased so as to decrease the pace of the horses. The height of cut could be regulated, and a contrivance was attached for throwing it in and out of gear. Later improvements were applied to the cutter, in which the finger bar was ribbed or flanged so as to increase strength, while the knife bar received a greater freedom of motion, thus making it less liable to choke, and causing a lessening of draft. The grain fell on a platform tipped by the foot of the raker, who, with the assistance of the rake, could make a very neat gavel. A pole was introduced, which could rise and fall, thus making it easier for the horses than a rigid one."

"These are some of the improvements made in England on the Hussey machine up to 1862. Burgess and Key also made at this time a manual delivery which became a favorite on small farms. It differed from some of its class in having both traveling wheels as drivers, and in having them in advance of the cutter bar, the castor being behind it. Besides a tipping platform it had a conical screw divider which revolved inward and was driven by the weight of the grain, thus not only separating the grain, but pushing it toward the raker. It was also used as a grass cutter. Cuthbert, of Bedale, also improved the Hussey, making a very good machine. He increased the size of the drive wheels and suspended the cutter bar by a spring so as to lessen the friction. The speed of the knives was made less, but the stroke longer than in the original Hussey. Shafts were used instead of a pole, thus giving steadiness of draft. The height of cut could be regulated by tipping the machine."

"Jack & Son, of Maypole, began the manufacture of reapers in 1869, by improving the Hussey, and succeeded in making good machines, although their improvements were mostly in details. In 1860 Brigham and Bickerton introduced their 'Buckeye', an improved Hussey with a hinged cutter bar adjustable to different heights. It had a light draft and was almost too frail. It was both a grain and grass cutter with different cutter bars for each operation."

"Samuelson's 'Patent Eclipse' was a one-horse machine, simple and light, and with an absence of gearing, the driving wheel communicating its motion directly to the knife by means of a lever pinion."

"Most of the above machines which have the clipping principle (as did most of the Hussey type) come under the head of grass mowers, and were ordinarily used as such, although they could be used as reapers."***** "The mower advanced in great measure hand in hand with the reaper, so that it is almost impossible to separate the two in the early stages of development." *{}**** "The point at which they did diverge was in the construction of the knife, the reaper taking a toothed edge section and the mower the more rapidly vibrating sickle with the smooth-edge sections." ***** "All the successful English machines at this time were but modified forms of the American machines, so that it is to this country that we must look for the original patterns and the true development of harvesting machines." (20, p. 15-22)

American reapers. 1/

Space permits the mention of only a few of the American reaping machines. In (10, p. 212) appears this statement:- "The invention of American horse-power mowing and reaping machines dates from patents issued as early as 1803, but not until a generation had passed were any effective devices introduced, and before 1840 their use was so limited as to have no effect on harvesting costs or crop acreage."

During the first three decades of the nineteenth century inventors were busy trying to build a practical reaping machine. The early machines - some of which were pushed through the grain, while others were drawn - embodied a number of different principles for the cutting mechanism.

"American invention in this line, so far as there is any record, began with the patent issued to Richard French and T. J. Hawkins, of New Jersey, May 17, 1803." (8, p. 45)

A short description of this machine is given by Woodward as follows: "From the meager data available, we learn that the reaper was supported on three wheels, one wheel extending into the grain. The horses drew in front on one side, opposite the cutters, which were a series of scythe knives revolving on a vertical spindle. Beneath the cutters were long wooden fingers extending some distance into the grain and separating the grain to the action of the revolving cutters. Directly behind the cutters were fingers that passed between the cradle fingers and removed the cut grain which fell to the ground ready for binding. It is reported that the machine was put into operation and actually cut a large quantity of rye, but apparently it was not constructed on practical principles." Woodward continues:- A patent for reaping machines was granted to Samuel Adams of New Jersey on December 28, 1805, but a description of this machine is lacking." (35 p. 14)

"On December 4, 1812, Peter Gaillard, of Lancaster, Pennsylvania, was granted a patent for a grass-cutting machine, the first of its kind in America, all machines before this time being intended for cutting grain and not grass; thus the idea of mowing grass by horsepower with a machine built solely for that purpose originated in America, although the machine invented by Smith, of Deanston, in 1811, was designed primarily for cutting grass." ***** "Gaillard's machine was of little consequence." (20, p.22-23)

"Five patents of no general importance were issued between that time" (May 17, 1803, the date of the French and Hawkins patent,) and "February 13, 1822, when Jeremiah Bailey, of Pennsylvania, took out one for cutting grass or grain. This machine was supported on two wheels, one only being the driver; the horse walked to the side and front, and the circular scythe frame projected into the grain. It was the first to indicate the principle contained in a flexible bar, as 'with the inequalities of the ground the scythe frame, shaft, and trundlehead rise and fall.'" (8, p. 45)

1/ The mention of firms now in existence does not imply any particular endorsement by the Department.

A fuller description of this machine is given by Miller as follows:-
"The cutter was shaped like a low-crowned hat, the crown being 3 feet 5 inches in diameter and the brim about one foot wide. This was of wood, with the exception of the knife which formed the edge of the brim. The knife was kept at the proper distance from the ground by a shoe, so arranged that the distance could be increased or diminished at will. The horse walked ahead beside the grass. This was the first mower machine that met with the slightest success, and it was used to some extent in practical work." (22, p. 23)

"E. Cope and J. Hooper, Jr., of Pennsylvania, obtained a patent May 18, 1825, for a machine which was considered simply as an improvement on the Bailey, having the same general principles, but being less complicated in construction. It is claimed that this machine worked well." (8, p. 45)

The patent issued in 1828 to Samuel Lane is mentioned under combined harvesters and threshers.

Erastus Ingersoll, May 7, 1830, patented "A grass-cutter of the rotating-cutter type, and, although it never attained much distinction, it was a clean invention that should not be forgotten."

"The next invention was one of considerable importance, and although it was built as a reaping machine, its cutting apparatus was an important step in the improvement of both mowers and reapers. The invention was that of William Manning, of New Jersey, patented May 3, 1831. It had two ground wheels fixed to the same axle, from which a frame extended, having a bar attachment held in place by two arms, and provided with teeth 6 or 8 inches in length, extending forward into the grain. A flat bar of iron lay upon this bar, bearing spear-shaped cutters sharpened on each of their edges. These were about six inches long, and cut the grain as it was held by the teeth. This was substantially the scalloped sickle, and was Manning's original patent, resembling much the celebrated cutters of Hussey and McCormick, which afterwards became so important. It had a grain divider, the first on record in America."

"In 1833 there were three inventions before the Hussey patent was granted, one of which was by William and Thomas Schnebly, and had an intermittent endless apron for forming gavels. It was not a success." (22, p. 24)

"Hussey's machine" (patented December 31, 1833) "was principally remarkable for its compact form, its hinged frame, and for the novel construction of its guard-teeth, which were made double or slotted, so that the scalloped or zigzag knife might vibrate through the openings, the space between each guard, from center to center, being as wide as the distance between each point on the knife or sickle. This was a marked improvement, and the machine was really the first one made sufficiently practical to find a regular market, and to come into general use. Its manufacture began in 1834; it was introduced into different States immediately following; it was built in substantially the same form (though guards were improved in 1847) continuously up to about the time of Hussey's death." (8, p. 45)

Miller describes the knife in the Hussey machine as "A series of triangular plates riveted to a flat iron bar, and forming a kind of coarse-toothed saw. One end of this saw was attached to a pitman moved by a crank and receiving its motion from the main axle by means of cogs."

Rogin is authority for the statement that "The sale of the first Hussey reaper in 1833 marks the appearance of horse-drawn harvesting machinery in the husbandry of the country." ***** "By the end of the decade Hussey had built and distributed about 45 machines in different parts of the country. It may be confidently asserted that this constituted the only output of practicable reapers during the thirties." (26, p. 73)

"Hussey's machine" ***** "as patented and first constructed was mounted on two wheels, to the rear and somewhat to the right of which extended a platform with the cutting apparatus on its front edge. This platform was at first supported in the rear by a roller, and later a wheel was added at its outer edge. The cutter was the unique part of this machine." (22, p. 24)

"To Bernard Jackson, of Ohio, was granted a patent, June 14, 1834, for a four-wheeled reaper having 'discharging arms, which are to deposit the grain as it is cut behind the left side of the machine.'"

"The next patent was granted to Cyrus H. McCormick, of Virginia, June 21, 1834." (8, p. 45)

In his description of the McCormick machine Miller relates that "It was drawn by one horse hitched in shafts and walking beside the standing grain. The drive wheel was situated almost directly behind the horse, and through a series of cogs gave a reciprocating motion to the cutting knife. The knife was about 4 1/2 feet long, with an edge like a sickle, and worked through wires projecting before it, which held the grain while being cut. Behind this was an apron or platform 5 or 6 feet long, made of thin plank, from which the grain was raked by a man walking behind the machine. At the outer end of the platform next to the grain was a partition consisting of a cloth-covered frame, to divide the cut from the uncut grain. There was a reel six or seven feet in diameter and as long as the knife, fastened just over the cutter and made to revolve by a band connected with the main axle." ***** "The patent specifications of 1834 described the machine essentially as follows:- "It was borne on two wheels with a platform back of the cutter, so arranged that the sheaves were to be raked off to one side, out of the way of the next round. The larger wheel was on the side farthest from the grain, and by means of a crank and cogs caused to vibrate a straight-edged knife, which is described in the specifications as 'having the edge either smooth or with teeth, either with stationary wires or pieces above and below and projecting before it for the purpose of a steadying the grain while cutting, or using a double crank and another blade or vibrating bar.' The machine also had a divider to separate the cut and uncut grain, and a large reel to hold the grain against the knife. The patent also specifies that it is to be either drawn or pushed. Thus it is seen that the machine as patented corresponded very closely with the one described as in use in 1833, so that, while the patent was not granted until the next year" (June 21, 1834) "McCormick as well as Hussey had his machine at work in the harvest of 1833." ***** "McCormick's machine was undoubtedly invented prior to this time, as he had a machine which operated in the harvest of 1831.

According to McCormick's own statement in his communication filed when seeking an extension of his patent in 1848, this early machine was essentially the same as that patented in 1834. Be that as it may, it is certain that he had a machine invented in 1831, and that it was tried in that year." (22, p. 24-25)

Rogin asserts that "In 1840 McCormick sold his first machine, and the production of reapers during the forties is represented, with minor exceptions, by the output of Hussey and McCormick machines." ***** "The number of Husseys and McCormicks sold prior to 1845 was negligible, and the sale of reapers for the harvests of 1849 and 1850 materially exceeded the aggregate for the years 1833 to 1848 inclusive." (26, p. 74, 76)

"The most important part about each of these machines" (Hussey's and McCormick's) "is the cutting apparatus, and these being the pioneers in successful cutters they should be examined in detail."

"Hussey's cutter" ***** "is really a novel and surely an original feature of his machine. Although a vibrating knife had been used before, it was not like this, and nothing resembling the slotted fingers had ever been known. These fingers, or guards, were formed of a top and bottom piece, joined at the point and near the back, but leaving a slot through which the knife played. They were fixed securely into the bar on the front edge of the platform at intervals of about three inches, and extended forward into the grain about seven or eight inches. The cutter, or saw, was formed of thin triangular plates of steel (being made from old saw blades in the first machine) which were riveted side by side in a flat bar. They were 4 1/2 inches long and 3 inches wide at the base, but terminating in almost a point. They were sharpened on both edges and beveled from both sides." ***** "The action, then, was not on the shearing principle as in Bell's machine, but was rather a chopping or clipping action. The patent specifications state plainly that 'the saw teeth shall play clear over the guards both above and below,' so that the invention could not have been copied from Bell's shearing plan, as has sometimes been claimed. The doubly beveled sections and closed guard were soon found to be faulty, as the cutters were especially liable to clog. Another feature had considerable to do with the clogging, and also increased the draft greatly, i.e., the acute angle which the blade formed with the guard. In order to remedy this difficulty some changes were soon made. The blade was shortened and made more obtuse. About an inch of the edge of each blade near its base was left flat below and beveled only from above, in order to shear the trash and grass which gathered in the back part of the slot, and lastly, the guard, instead of having a closed slot, was open at the back and upper part, this last modification constituting the principal feature of Hussey's patent of August 7, 1847. As time went on and many inventors applied themselves to the improvement of this form of cutter, more and more of the edge of the blade was left in contact with the guard below, and the blade became more and more obtuse." ***** "Thus it is seen that while Hussey's invention contained features vital to the reaper, it had a greater effect upon the development of the mowing machine, and was more strictly a type of mower than of reaper."

"McCormick's cutter" ***** "as first used consisted of a straight blade vibrating between projecting wires which held the grain while being cut. This blade, as the patent specifications say, was 'either smooth or with teeth,' and very probably the first machine tried had a perfectly smooth

blade, which very soon gave place to the serrated form. The arrangement of projecting wires to hold the grain while cutting was also used at first, but later a sort of finger was devised consisting of a strap of iron extending forward over the blade, and then bending back under it, leaving an opening at the back part and beneath. These guards were used until 1839. In 1840 the fingers were changed to double closed ones of the Hussey type, but, as in Hussey's machine, this closed finger had a tendency to cause clogging, and was changed for a later style as patented January 31, 1845. In 1841 a change was made in the serrations on the blade, making alternated groups of teeth to point toward each other, so as to incline toward the guards in the reciprocating motion. Then came the modification of the guards, as above mentioned, changing them to spear-shaped projections, flattened horizontally. Both these changes were incorporated in the patent of January 31, 1845; also 'the curved bearer for supporting the blade,' the reversed angle of the blade, the construction of the guards so as to form angular spaces in front of the blade, the combination of bow and dividing iron for supporting the grain, and the position of the reel post on the machine."

"In 1852 McCormick adopted the open finger guard of the Hussey type, and made the blade slightly scalloped on the cutting edge. Later the scallops were made more pronounced, finally developing into the obtuse-angled serrated section."

Following the introduction of the Hussey and McCormick machines various other inventions were brought out, mention of only a few of which will be included herein.

"As the mower and reaper were at first often combined in the same machine, some of the earlier patents referring to mowers must also be mentioned. The mower was at first simply the reaper dismantled of its platform and other parts not needed for grass cutting, although separate machines for this purpose were early constructed. As the mower required a higher speed of the knives than the reaper, no successful type of this machine was constructed until a device for accomplishing this was invented."

"William F. Ketchum, who has sometimes been spoken of as the father of the mower trade, since he was the first to put mowers on the market as a type of machine distinct from the reaper, took out several patents, but the one granted July 10, 1847, was of especial importance. The main features of this patent were the unobstructed space left between the driving wheel and the finger bar with its support, and the remarkable simplicity of the machine. The cutter was an endless chain of knives which never became successful, but which caused some excitement at the time. Ketchum afterwards adopted the Hussey type of cutter, and produced a very successful mower of the rigid-bar type. It was this machine that led the way in mower development and became the first really practical machine."

"Abraham Randall (or Rundell) of New York, April 22, 1835, patented a curious cutting device, consisting of two sickles or cutters with corresponding points to be operated in contrary directions, thus making a double shear cut with each pair of points; the whole acting as a series of double-acting shears. It was one of the most important of a number of inventions on this principle which were made in this country, and in England." (22; pp. 25-28, 40)

"Alexander Wilson, of New York, September 3" (1846) "got a patent on several devices, the one noticeable being upon the construction by which cutters may follow the undulations of the ground independent of and not affected by the up and down movement of the horse." (8, p. 46)

In 1847 "Hussey patented his open-topped guard, and McCormick received a patent for a raker's seat on his machine." (22, p. 30)

"James L. and H. K. Fountain, of Rockford, Illinois, May 15" (1849) "were allowed a claim for 'giving to a vibrating blade a compound transverse and horizontal cut by combining it with stationary teeth or a reel.' The old 'Fountain,' as after improved, was a popular machine in its day. A. J. Purviance, of Ohio, May 22, obtained a patent for constructing the platform separate from the other framework, so as to convert the machine easily into a mower or reaper as required. This was an important feature, and marked the beginning of practical combined machines." (8, p. 47)

Self-rake reapers and droppers

After describing the cutting mechanism of the Abraham Randall machine, patented April 22, 1835, Miller continued:- "This Randall machine also contained a raking and discharging device, which was among the first attempts at an automatic rake. Up to this time the raking had all been done by hand; but now, after the essential parts of the reaper were worked out, inventors began to endeavor to perfect the machine, and to solve the problem of a successful automatic device to remove the grain from the platform."

"The early devices for automatically removing the grain from the platform were varied and often crude." ***** The records show that "Bell used an endless canvas to lay the grain in a swath at the side, while Crosskill's English modification of McCormick's machine several years later used a number of Archimedian screws to accomplish the same purpose. These and numerous other devices were tried, such as reciprocating bars with pegs to work the grain to one side, and rake teeth penetrating a stationary platform below, as in Reed's machine." ***** "Finally, among the numerous attempts along this line came that which operated with rakes above a stationary platform, the type from which the self-rake was at last developed. Among the first of this class were the single-rake type, which raked directly backward with a horizontal motion. Others had a rake fastened to the reel, while some had single rakes sweeping a quadrant platform. Finally came the revolving fans, either on a vertical or an inclined axis, one of which raked the platform. Later the vanes or fans were all made alike, each being capable of sweeping the platform at the will of the operator."

"One of the first patented inventions which sought to deliver the gavels automatically was that of Schnebly, patented in 1833. It had a horizontal endless apron, traveling intermittently, and thus delivering the grain in gavels by the side of the machine. In 1838 Cyrenus Wheeler invented a machine with a revolving endless apron to deposit the grain in a box with a sliding bottom, which could be opened, thus dropping the grain in gavels."

"Jonathan Reed patented a machine March 12, 1842, that had a rake beneath the platform, with teeth projecting through the slots to remove the grain in gavels. He also introduced a form of cutter which possessed the peculiarity of serrated guards in combination with serrated cutters, but this never seemed practical. Clinton Foster, this same year, April 18, patented a form of rake which swept across the platform as controlled by the operator, and November 20, 1846 Andrew Cook patented a rake which was attached to the reel, forming a revolving reel rake, the first of its class. This latter machine was afterwards manufactured by Goble and Stewart, and had a revolving canvas back of the platform, upon which the grain was swept by this revolving rake, and thus transferred to the ground to one side."

An early patent for an automatic delivery was that issued to "F. S. Pease, November 14, 1848. It had a grain rake traveling sideways beneath the platform, with side slots for the fingers. Mann made one much like this the next year." (22, p. 30)

A harvesting machine which possessed some peculiar features was that of Ferdinand Woodward, patented September 30, 1845. This was an example of the "Push reaper." As its name implies "the harvesting mechanism was pushed ahead of the horses" instead of being drawn behind them. "The cutting device consisted of tempered steel blades of the shear or scissors type, not the series of blades oscillating through guard fingers developed by McCormick. Of each pair of shears the upper blade was about seven inches long and the lower about five and one half inches long. The lower blades were stationary, the upper ones pivoted near the base and fastened to a connecting rod that worked back and forth horizontally from gearing attached to the right front wheel. The cutters could be raised or lowered, and a divider separated the standing grain from that about to be cut. The cut grain fell upon a table, and the operator stood on a platform immediately behind to rake the grain into a sheaf box at the left side. When there was sufficient grain in the box to make a good-sized sheaf it was dropped to the ground by means of a treadle operated by the reaper's foot. It was this sheaf box and its combination with the platform on which Woodward claimed originality. At first there was no reel, but finding it difficult to cut grain that leaned away from the machine, especially in case of an adverse wind, the inventor soon added one. However, he did not show this feature in his application for a patent. The machine was steered by means of a windlass attached to the rear wheels and operated by the driver who rode on a small platform." (35, p. 14)

"On November 21, 1848, Goble and Stewart patented a rotary rake passing horizontally across the platform, and which was 'given an unequal motion for the purpose of raking the cut grain in an effectual manner.' Daniel Crushing, about this time took out a patent for an apparatus with revolving rakes. The next year, January 16, Oliver Barr patented a revolving rake and an inclined platform with a sort of trap door for the grain to fall through, a kind of dropper. This same year Haines conceived the idea of suspending the frame carrying the conveyor, reel, and cutter to axles of the bearing wheels, and hinged the frame to the tongue so that it could be tilted in raising or lowering the cutters, - an important improvement." (22, p. 30)

"On June 12" (1849) "a very important patent was granted to Nelson Platt, of Ottawa, Illinois, which was assigned to Seymour & Morgan. This was the first of the sweep-rake system, which afterward became so popular. The rake swept the grain off in gavels at right angles to the path of the machine. J. J. and H. F. Mann, of Indiana, June 19, patented a self-rake consisting of endless bands, which delivered the grain into a receiver, whence it was discharged by an attendant upon the ground in gavels." ***** "A few other patents were granted during the year, but not of any particular consequence."

"As soon as it had been demonstrated that grain could be successfully harvested by machinery, inventors directed their attention to its delivery, to provide mechanical methods for getting it off the reaper and in the best possible shape for binding, and so the various self-rakes and droppers were invented. The idea was not new" ***** "some of the earliest and crudest reapers had self-raking devices attached, but nothing came of them, naturally enough, as such attachments could not be of any value so long as the foundations upon which they must rest were not fixed. The reapers which must bear them had not been established."

"The year 1850 was not prolific in new features for reapers. J. L. Hardeman obtained a patent, August 20, for a platform guiding-board, in connection with an automatic discharging mechanism. It was afterward assigned and re-issued to William N. Whitely, of Springfield, Ohio, and was merged in the Champion system. E. Danford, of Geneva, Illinois, September 17, patented improvements on a double sickle. He made a fair machine out of this old idea. As a mower it was one of the best in its time."

"In 1851, Palmer & Williams obtained a patent, July 1, for their sweep-rake and quadrant platform. Assigned to Seymour & Morgan, of Brockport, New York, it entered into their system of self-rakes. July 8, William H. Seymour patented improvements on a self-rake. These were the foundation patents of the celebrated self-raker known as the 'New Yorker,' as manufactured by Seymour & Morgan. John H. Manny, of Waddam's Grove, Illinois, September 23 obtained a patent for hanging the cutter bar to the side of a triangular frame, so that neither end could sag; also for forker's stand back of outer end of platform. This was an important invention." ***** "It was one of the earliest of successful combined machines."

"In 1852 B. Densmore, of New York, obtained a patent, February 10, for a hanging drive-wheel in supplementary frame, hinged to and outside of the main frame, etc. It was assigned to D. M. Osborne and W. A. Kirby. R. T. Osgood, of Maine, obtained a patent February 17, assigned to and liberally re-issued by Cyrenus Wheeler, of Poplar Ridge, New York, for independent driving and supporting wheels on a common axle, carrying a rectangular main frame between them on the axle, also providing each drive wheel with ratchet-wheel and pawl, for the purpose so well known. This was one of the base patents on the old 'Cayuga Chief' and other such machines, and so was that granted to E. Forbush, July 20, which also went to Mr. Wheeler. It covered the rake, supported by pivoted connection in the rear of the drive-wheel axis, sweeping over the platform and delivering grain to the rear of the main frame. J. S. and D. Lake, same date, obtained a patent for flexible bar devices, assigned to and re-issued extensively by James Saxton, of Canton, Ohio. W. H. Seymour, December 14, obtained a patent for raker's stand on their old 'New Yorker' and supple-

mentary metallic frame for gearing. Jearum Atkins, Chelsea, Illinois, patented December 21, his automatic self-rake, which was truly an automaton. It picked up the grain, turned round and laid it off. It was a striking sight in the field, worked well and had large sale for two or three years, but 1857, with its heavy, tangled grain, and financial troubles, wrecked both machine and manufacturers." (8, p. 47-49)

In 1852 a man by the name of Hoffhain produced a rake that could operate as a reel - the early form of the revolving vane used on the reaper of today." (1902) "The device consisted of a vertical shaft carrying four reel arms so geared as to sweep the platform at regular intervals. The rakes were in pairs upon cross shafts, and the latter were arranged to rock, so that when moving over the platform they would come close to it, but in the rest of the revolution they were high above the gearing." (22, p. 31-32)

"In 1853, Thomas D. Burrall, of New York, patented, April 5, an additional apron to platform, to convert rear-discharge into side-discharge." ***** "J. H. Manny, April 19, patented cutter-fingers, and June 21, a sickle." ***** "W. and T. Schnebley, New York, December 20, patented a peculiar self-rake." (8, p. 49)

"A. J. Cook, who had received a patent on a revolving reel rake in 1846, took out a patent March 28, 1854, for a reel rake sweeping backward, which was assigned to Cyrenus Wheeler." (22, p. 32)

"Abner Whitley, August 22," (1854) "obtained a patent for a conical track-clearer, and September 19, for suspending rake to one of the reel-blades, a very important patent." ***** "C. Wheeler, December 5, patented a hanging finger-bar. W. F. Ketchum, assignor to R. L. Howard, Buffalo, New York, December 19, patented a segmental rim for drive-wheel, to be used off or on in reaping or mowing." ***** "In 1855, J. E. Newcomb, on January 9, obtained a patent for a dropper and other devices, assigned to J. F. Seiberling, Akron, Ohio, who was the acknowledged head of the dropper system. Cyrenus Wheeler, February 6, obtained a patent for a combination of a hinged finger-beam and a side-delivery platform." ***** "The old 'Cayuga Chief' was built under his patents principally - in fact he was one of the chiefs of the two-wheel jointed-bar fraternity, and his works live." (8, p. 49)

Referring to the Newcomb patent assigned to Seiberling, Miller adds, "The dropper as now" (1902) "used, consists of an attachment behind the cutter-bar, which holds the grain until enough has been accumulated for a sheaf, when it is lowered and the grain allowed to slide off. The first invention along this line was by Ogle (1822) who had some such arrangement on his machine." ***** "Other devices have been used, such as one by Wheeler, in 1938, which delivered the grain by a canvas into a box, from which it was dropped." ***** "The most approved form, however, consists of a number of slats fastened to the rear of the cutter bar, and which may be raised and lowered at the will of the operator. It is used to some extent at the present day," (1902) "especially for particular purposes, as for bunching clover when cutting for seed." (22, p. 32)

"Cyrenus Wheeler, February 6," (1855) "obtained a patent for a combination of a hinged finger-beam and a side-delivery platform." ***** (9, p. 49)

"Walter A. Wood, Hoosick Falls, New York, March 25," (1855) "obtained a patent for giving the inside of the grain-wheel a conical shape for track-clearing, and for improvements on platform. Moses G. Hubbard, New York, June 4, obtained a patent for an angle iron bar." ***** "J. Richardson obtained a patent, June 19, for a self-rake, afterward assigned to Walter A. Wood. J. E. Heath, of Ohio, September 11, obtained a patent for a cam gear in center of drive wheel." (8, p. 49-50)

"In 1856 Owen Dorsey patented a self-rake, which was an improvement on the Hoffhein type, and was an important patent in the development of this form of machine. It is operated much like the Hoffhein machine, having 'rakes which rise and fall as they rotate, and as they approach the front part of the platform descend to the level of the latter and sweep over it, raking the cut grain therefrom, and then rise at the discharge end of the platform out of the way.' At first the operator could not ride, but this difficulty was overcome by the patents of T. Whitenack, February 5, 1861, and of others. This is the first patented invention of revolving reels on a vertical axis, as the invention of Hoffhein was not patented. At this period there were a great number of devices using simply a single rake for sweeping the platform, but with the last named invention the first types of the present self-rake made their appearance." (22, p. 32)

"Cornelius Aultman and Lewis Miller, assignors to Ball, Aultman & Co., Canton, Ohio, patented, June 17" (1856) "a double rule joint or double-jointed coupling for finger-bar machine. Patents were issued to M. G. Hubbard, September 2, for his self-rake; and the same date to William A. Kirby, for drive-wheel having no outer frame support, for the construction of his two-part frame inside of drive-wheel, and for hinged lever seat. Pells Manny, of Illinois, October 21, obtained two patents for the construction of sickles and stirrup brace for finger bar. William N. Whitely, of Springfield, Ohio, November 25, covered improvement on his self-rake for balancing by connecting driver's seat with front end of frame, and also for controlling the rake." (8, p. 50)

"D. M. Osborne and W. A. Kirby, February 10, 1857, secured a patent covering a reel supported on a single post, a feature afterward incorporated in the Kirby, a popular machine of that day." (22, p. 32)

Several other patents were issued in connection with raking devices in 1857, among which may be mentioned two patents to Walter A. Wood in February, one being for raker's seat, and the other for shoe track-clearer." ***** "And John P. Manny, July 14, an improvement on self-rake."

"In 1858, J. L. Fountain, of Rockford, Illinois, patented January 12, a self-rake. F. Nishwitz, of New York, February 16, patented a lever pawl and chain for raising floating cutter-bar. It is said that Nishwitz was one of the first to construct a practical jointed-bar machine, but was too poor to go on with it. George S. Curtis, of Chicago, patented February 28, his cam reaper. Lewis Miller, Canton, Ohio, May 4, obtained a patent relating to front-cut, jointed-bar machines, for hinging, raising and folding cutter bar on the 'Buckeye' and, same date, on combining reel with hinged platform so as to preserve their relations when undulating. These were important patents. L. J., W. S., and C. H. McCormick, May 11, secured a patent for construction of finger-bar, liberally re-issued after-

ward; John P. Manny, July 6, four patents on his machine; C. H. McCormick, September 21, on shape of guard fingers; McClintock Young, Maryland, same date, who then began the foundation of what was known afterward as McCormick's self-rake; James S. Marsh, Lewisburg, Pennsylvania, November 16, on lever and adjustment of finger-bar."

"In 1859, William N. and Andrew Whitely, obtained a patent, January 18, on guards and sections; J. S. and H. R. Russell, of Maryland, March 29, for improvements on reel rake, assigned to J. F. Seiberling, and forming part of his system; S. A. Lindsay, of Maryland, August 2, for a real rake arranged to accomodate itself to a hinged platform, also covering the important combination of a quadrant platform, hinged finger-beam and frame supported by two wheels; Obed Hussey, August 23, for raising and lowering device for his machine - his last patent; E. Ball, October 18, drag-bar and swiveled coupling-arm and finger-bar; William A. Kirby, November 15, location of raker's seat on Kirby reaper." (8, p. 50, 51)

In the fifth decade of the nineteenth century mowers that were definitely separate from reapers began to come into use, as shown by the following statement:- "The patents of Cyrenus Wheeler in 1856 marked the beginning of the modern two-wheeled mower with a flexible cutter-bar, a machine entirely distinct from the reaper." (10, p. 295)

Among patents issued in 1860 are the following:- one to "Lewis E. Reese, New Jersey, April 10, for improvement on revolving reel-rake to enable driver to ride comfortably; F. H. Manny, of Illinois, August 20, for hinged cap and shoe; Walter A. Wood, September 11, on his self-rake or automatic fork; McClintock Young, September 18, obtained a valuable patent for 'combination of a revolving reel shaft carrying diverging reel gatherers supported at one end only, the fixed double-walled cam and the rake revolving around said shaft, and oscillating on an axis both eccentric and transverse to said shaft, with a counterpoise to equalize the movement of said rake; 're-issued after assignment to the McCormicks. This, combined with other devices, became the McCormick self-rake."

"In 1861, D. S. Morgan obtained a patent, January 22, for reel support; J. S. Marsh, May 21, for rake; Walter A. Wood, November 19, covering improvements on his well-known self-rake now practically invented; D. L. Emerson, of Rockford, Illinois, December 10, on combination of wheel and divider, one of his many patents."

"In 1862, Ralph Emerson, on January 14, obtained a patent relating to a lever-bar and attachment of guards; Samuel Johnson, November 4, for his sweep-rake, mounted directly and wholly upon a suspended hinged joint finger-beam."

"In 1863 a patent was issued to James S. Marsh, February 10, for revolving rake and reel, the arms of which are hinged to the revolving head independent of each other, etc., and to Reuben Hoffheins, Pennsylvania, November 3, for self-rake mounted on finger-beam and rotating on a vertical axis, or nearly so."

"In 1864 the most important patent issued on reapers was to O. H. Burdick, January 7, for his rake, which was one of the D. M. Osborne & Co. system. In 1865 a patent was issued to Samuel Johnston, February 7, assignor to himself and R. L. Howard, of Buffalo, New York, for his celebrated reel

rake. In this all the arms carried rakes, and were each hinged independently and all controlled by the driver; to John A. Dodge, of Auburn, New York, May 23, for construction of main gearing, etc.; to William N. Whitely, August 29, for Champion self-rake; to Lewis Miller, of Ohio, November 21, for his well-known table-rake, i. e., table upon which grain falls, and revolving rake beneath, to sweep it off to the side and rear; to A. J. Manny, "***** November 28, for hinged cutting apparatus, and to William N. Whitely, December 5, for improvements on drag-bar."

"In 1866 three patents were issued to William N. Whitely, January 30, for improvements on the Champion; one to O. H. Burdick, assignor to himself and D. M. Osborne, February 27, for rake and reel; one to Adam R. Reese, of New Jersey, May 1, for revolving rake in connection with driver's seat, and one to William N. Whitely, August 21, for reel and rake independent of reel for hinged platform. In 1867 a patent was issued to L. J. McCormick, and L. Erpelding, January 15, for supplementary frame, hinged finger-beam worked by lifting and locking levers, and to Amos Rank, February 12, for longitudinal drag-bar, and other improvements on the 'Etna' machine."

"In 1868, James S. Marsh obtained a patent January 21, for devices on his rake; Rufus Dutton, February 11, five patents on reaper construction; C. Wheeler, April 21, two patents on rake and on machine; G. W. N. Yost, of Corry, Pennsylvania, June 9, five patents on devices pertaining to the 'Clinax' machine, mowing and reaping. In 1869 John Barnes, of Rockford, Illinois, obtained January 12, two patents on his self-rake machine; Amos Rank, of Ohio, May 4, one covering devices for dropper; Eph. Myers, of Maryland, December 4, for dropper; T. F. Lippincott, of Pennsylvania, December 21, for dropper; and L. J. McCormick, L. Erpelding and William R. Baker, for over-hung reel in connection with rotating turning rake mounted on the finger-beam."

"The inventions that have been noticed in the foregoing bring us down to 1870, to the time when foundation features of reapers had all been invented and substantially perfected. It is therefore unnecessary to pursue the subject farther, especially since the reaper had by this time begun to beat a retreat in the harvest fields of the West before the advance guard of modern harvesting machinery." (8, p. 51, 52)

The acreage of small grain that could be grown profitably when its harvesting was accomplished with the aid of hand tools alone naturally was very limited. The harvest season was short, and unless the grain was cut within a short space of time much of the crop would be lost. Designing a machine was only one step, and perhaps not always the most difficult. Competition between rival manufacturers was keen, and until the worth of their products had been demonstrated the farmers were apt to be somewhat slow in adopting them.

Having traced to some extent the inventions of various machines for harvesting grain crops grown in the United States it should be of interest to follow their introduction into actual use.

"Up to 1840 the reaper had hardly succeeded in establishing itself with the farmer as a practical machine. Grain was still reaped with the cradle." ***** "Hussey had begun the manufacture of his reaper at Baltimore only two years previously. Several public trials had been held, but as yet comparatively few reapers were in use, and those mostly in the

East. The early machines were roughly built and had a heavy side draft. Often the horses had to be driven at a trot before the machine would cut. Where the grain was lodged they failed to cut, and many complaints were also made of breaking parts. But in 1845 the Hussey and McCormick machines were coming into use in the East. It was said in Virginia that probably not less than \$15,000 was spent for reapers during the summer of 1846." (10, p. 288)

While the development of the reaper extended over a period of many years this type of harvester was in farm use during a relatively short period. Almost as soon as the cutting mechanism for the reaper was developed to the point that it gave satisfactory performance, inventors were busy in endeavoring to work out an attachment for the reaper that would automatically bind the grain. With the development and introduction of a successful grain binder near the close of the nineteenth century the reaper began to give way to its successor, after being in general farm use about 50 years. However, a few self-rake reapers are used at the present time, (1939) as several manufacturers of farm machinery offer them to the farm trade.

Harvesters and binders

The invention of equipment for the harvesting of small grain crops (both the hand tools used in the very early days, and the early forms of machines devised for that purpose) have been traced to some extent down to the latter part of the nineteenth century. Not every invention has been named, but it is believed that the most important ones excepting binders and combined harvester-threshers have been at least mentioned, even if not fully described.

Ardrey, (8, 53) takes the position that the term "harvester" should include strippers, headers and combined harvester-threshers. As strippers and headers have already been written up at some length in this article, and as combined harvester-threshers will be included later, the following data will relate more particularly to binders or binding devices designed to be attached to self-rake machines, called the "low-down" class, and those designed to elevate the grain to the binder.

Since early in the nineteenth century inventors have undertaken to solve the problem of caring for our small grain crops. They have given us the harvester, reaper, binder, and combined harvester-thresher. Not all machines that were patented proved to be practical, but as improved some of them have played a most important part in our agricultural life during the past hundred years.

Under the general heading of "Harvesters" Ardroy (8, p. 56) mentions the following:-

"In the summer of 1850 Augustus Adams and J. T. Gifford, of Elgin, Illinois, built a machine and made application for patent (which was afterward withdrawn) on 'improvements for cutting and gathering grain either by

the reaping or heading process.' The cut grain was delivered by means of an endless canvas apron into a receptacle at the side which was like a wagon box and upon wheels, and falling upon the floor was lifted therefrom by two or more attendants, riding in the box, and placed upon a table along the outer side, where it was bound. This machine was tried in the harvest of 1850 or 1851 and was probably the first in the field, with men riding thereon, who bound the grain as cut." (8, p. 56)

After the death of Mr. Gifford, Mr. Adams and Philo Sylla "began on a machine of a different character, which was patented September 20, 1853. This carried three men upon its platform to bind the grain, which was forked or shoved around to them by a fourth man. A box was attached to receive the sheaves and carry them until enough was collected for a 'shock' when they were dumped upon the stubble. It contained another principle; the finger-bar was hinged to the main frame, allowing it to 'vibrate perpendicularly and accomodate itself to uneven ground.' On account of the latter feature, particularly, the patent was purchased by C. Aultman & Co., to whom it was reissued in six divisions. Unquestionably it was one of those inventions which set a stake, so to speak, and if the inventors had comprehended all the possibilities of this machine, as well as of the other which they abandoned, and had thoroughly followed them up, they might have reaped great advantages therefrom. But as a harvester, this last carried so many men that it was too heavy and cumbrous, and the facilities for handling the grain were not sufficient to enable the operator to take care of it, especially if heavy or tangled. They built a hundred or more of them and then discontinued."

"April 1, 1856, A. Elliott, of California, patented a complicated machine by which grain, after being cut, was formed 'into sheaves or bundles, by means of a series of endless bands and rollers having an intermittent motion,' which were bound by boys during a stop in the revolution of the compressing apparatus that grasped the bundles. The machine was not practical and it added nothing to progress."

"Ezra Emmert, Franklin Gover, Illinois, January 19, 1858, patented a machine with an apron delivery, his claim being for the 'peculiarly constructed apron and retaining hooks, in combination with binding hook and platform for purposes specified.' This was never put upon the market. Possibly both these latter machines should have been classed with binders on account of their devices for forming bundles, but the tying was done by hand." (8, p. 56, 58)

Referring to the different types of reapers Bidwell & Falconer, quoting an Illinois correspondent in 1850 to the Cultivator, new series VIII (1851) p. 41, states:- "I would say these machines are worked by horses, sometimes two being used, but more generally four. Some of the machines require the horse to go by the side of the standing grain, while the machine works on one side. The cutting apparatus of others is directly in front of the horses. Some drop the grain directly behind, which must be bound before the machine comes round again, while others drop it at one side, and the whole field may be cut before any of it is removed. Some require a man to rake the grain from them; others are constructed for self-raking, and one has been brought out into the field the past season that does its own binding." (10, p. 290)

This last statement seems to fix the introduction of the automatic binder as about 1850.

It is believed that most, if not all, the important attempts to construct grain harvesting machines have been fairly well covered from the early days down to the advent of the Marsh harvester, the original patent for which was granted August 17, 1858, to C. W. and W. W. Marsh. It was the belief of these inventors that "two men might bind the grain cut by a five-foot sickle in ordinary motion, provided it could be delivered to them in the best possible position and condition for binding, and they could have perfect freedom of action. They knew that" ***** "only a free swing and an open chance at the grain would enable them to handle it; so they arranged the elevated delivery, receptacle and tables, and the platform, with these ends in view, that the operators alternating in their work regularly might have equal advantages and facilities for binding, and that their weight might give necessary traction and balance. This was their original invention without reference to the original patent." ***** "The bundle carrier with its castor wheel, shown in first patent, was as, it proved, an unfortunate afterthought. It was not built with the first machine, and was no more necessary to it than such attachments have been to other harvesters."

"The second Marsh harvester was built in Chicago in 1859. It worked admirably through that harvest, and aroused much enthusiasm and courage in the inventors. In 1860 they attempted to put up a dozen at home; but they were fifteen miles from the railroad; the work was partly done in Chicago, partly at De Kalb, and partly at home and around among the blacksmiths. The machines came together badly, and had neither strength nor capacity for the extraordinary weight and height of the grain grown that year, so these failed except one or two, which were patched up and pulled through - but the men handled the grain when it could be gotten to them. This was a serious disaster, and everybody interested in the inventors advised them to give the thing up, except Lewis Steward, of Plano, Illinois, who saw one of the 1860 machines work; so they went to Plano, and in connection with Mr. Hollister, a thorough mechanic, built a harvester which, though somewhat imperfect in details, had the required strength, mechanical action and capacity for all kinds of grain. This was experimented with and improved during the years 1861, 1862 and 1863, and seeming sufficiently practical, the manufacture of harvesters for the market began at Plano in the Fall of 1863 by Steward & Marsh. Fifty were begun, only twenty-six being completed, but they gave fair satisfaction in the harvest of 1864, and the balance of them, improved somewhat, were successfully marketed in 1865."

"From the time of the invention of this machine until 1871" ***** "none like it was on the market, or publicly known except in patents. In 1871 Mr. Ellward had six machines built at Plano - a modification of the Marsh; and about this time W. R. Low got out his machine, which was a change in another direction. Ellward's machine became well known in time as the St. Paul harvester, and Low's improved by himself and Augustus Adams, as the Low, Adams and French harvester." ***** "Along in 1872 and 1873 other parties began making harvesters, and also experimenting with automatic binders attached." ***** "As also did the Marsh licensees, at first sending

out both the hand and automatic binding attachments, and as the latter became perfected, dropping the former altogether. The McCormicks began putting out harvesters in 1875, and wire binders in 1877 and others came in later. Thus as the years rolled along hand binding gradually gave place to automatic binding, with wire at first and cord at last." *****

"Of straight harvesters - carrying men to bind - there had been made up to and including 1879, over 100,000, of which about two-thirds had been produced by the Marsh combination, and the rest by outsiders." *****

A patent dated April 10, 1860, was issued to B. F. Witt, of Indiana, "for a harvester which had a supplementary carriage attached with saddles for binders." Another patent, about a year later - March 5, 1861 - was granted to C. Alvord, of Wisconsin, "for a harvester which had a reciprocating gavel carrier to deliver gavels alternately at each end of a trough, to be bound.

"C. W. and W. W. Marsh, January 5, 1864, patented improvements on their harvester, for projecting part of the elevator forward, the better to carry up butts of grain," ***** A patent was obtained by "J. W. Harvey, of Iowa, December 27, 1864, on an auxiliary concave receiver, gate and gaveling fingers, for seizing the grain to facilitate binding." Another patent was obtained by C. W. and W. W. Marsh, February 14, 1865, "covering scalloped gatherer or hollow inside divider with hinged extension;" ***** "J. Emery, of Iowa, June 25, 1867, obtained a patent for rotating binders' station in connection with a harvester. This idea was further developed by J. D. Easter & Co., some years after. J. Lancaster, of Maryland, August 29, 1867, patented for a harvester a rake and fender, in connection with binders' platform in rear of grain platform. C. W. and W. W. Marsh, November 12, 1867, secured a patent on a single driving belt for harvester platform and elevator with adjustable tightening pulley, etc.; J. Underwood, of Iowa, June 9, 1868, patented his harvester in which 'the grain as it is felled by the cutter is moved backward and upward and delivered upon a platform upon which it is moved laterally toward the inner side to a position where it may be conveniently bound by hand' - the grain being moved by a reciprocating follower." ***** "C. W. and B. F. Witt, of Indiana," (obtained a patent) "August 4, 1868, on a tipping rake to receive grain and deliver to binder, and binder table in combination with tipping rake." (8, p. 58-61)

That the invention of successful machines for the harvesting of our small grains was not an easy matter seems to be proven by the statements of George K. Holmes, who, in referring to a general trial of mowers and reapers held in Geneva, New York, in 1852, relates that "Nine machines contested." ***** "Nineteen years had passed since the first patent had been issued. Out of the nine machines exhibited not one could start in the grain without backing to get up speed. There was a heavy side draft; the machines were clumsy, and they could not turn easily." ***** "In 1857 there was a trial at Syracuse, New York, at which nineteen machines contested. Of these, all except three started in the grain without backing to get up speed. There was a trial at Auburn, New York, in 1866, at which forty-four different machines were entered, and of these forty-two did their work in a satisfactory manner." (16, p. 318-319)

Despite some failures and disappointments of some American inventors in their efforts to produce satisfactory machines for grain harvesting, it would seem by the record of a French exposition held in 1855 that they were more successful than some of the inventors across the sea. It is said that

in the exposition mentioned "there was one English, one French and one American machine. The French machine did its allotted work in 72 minutes, the English in 66, and the American in 22" - or in just one-third of the time required by its nearest competitor. (16, p. 318)

Ardrey divides the "invention and development of self-binders" ***** "into three eras, the first comprising the earlier efforts, which were confined chiefly to the adaptation of binding devices to reapers - some as attachments operated by attendants, and some complete and automatic throughout, but all, substantially, upon what is called the 'low-down' theory. Every kind possible of material was used and every conceivable form of binder was tried, but all failed to the extent that none established itself in the market. The second era began with the adaptation of self-binders to the Marsh harvester, and runs through the various stages of development in wire and twine binders, and down to the time of the third, or current era, wherein all useless and impracticable devices have been eliminated, all material for bands has given place to twine, and all machines upon the market, with one or two exceptions, are substantially alike in form and general principles." (8, p. 64-65) (It should be remembered that the foregoing statements were published in 1894.)

Miller states that "early devices for binding were very crude." ***** "Materials used for the band in these early forms were of three kinds - straw, wire, and twine - various attempts being made to use each of these materials. Many of the early devices, although automatic in the binding, required an attendant to furnish the power, while others required an attendant also in helping to bind." (20, p. 34)

"John E. Heath, of Warren, Ohio, was the first of record to attempt to bind grain by machinery, and his was a twine or cord binder. His patent was dated July 22, 1850." He made five claims in his patent, which may be stated as follows:- "First; Gathering the grain and compressing it into a sheaf substantially as herein set forth, by means of the rake and standard. Second; Carrying the cord around the sheaf and holding the latter until the band is tied by means of the curved lever and toothed arm substantially as herein described. Third; The employment of split thimble and sliding hook to aid in tying the band. Fourth; Alternating the rake to gather the grain and compress the sheaf, by means of the spring, strap, and drum, substantially as herein set forth. Fifth; Bridging the space through which the bound sheaf drops, to support the grain while it is being gathered, substantially as herein set forth." (8, p. 65)

Referring to the Heath patent Miller adds the statement that "It was on the 'low-down' principle, as were all the early machines, and the rake mentioned in the first claim worked beneath the platform." (20, p. 34)

Ardrey states that "Little is known of Heath's binder except from his patent. It is said that he built several machines and that they operated fairly well for a first effort." It is inferred by Ardrey that "they must have given good promise as he" (Heath) "sold the right to the Southern portion of Illinois for \$4,000 to S. H. Tudor in 1851, and made other transfers on record."

"The next patent for a binder was granted to Watson, Renwick & Watson, May 13, 1851. Their first claim reads as follows: 'The method of raking and binding grain with one operation, by the mechanism herein specified, or its equivalent.'" ***** "The next claim related to the self-rake, which was a toothed arrangement, sweeping the grain lengthwise of the platform and delivering to the binder located at the end. Their claim reads:- 'The method of adapting the binding apparatus to the length of the cut grain; either by moving the cutting apparatus backward and forward to accomodate the binder, or by moving the binder nearer to or further from the front of the platform in such a manner that the sheaf may be bound near the middle of its length' etc. The next claim covers the automatic principle, the parts 'acting in connection and automatically, by motion derived from or dependent upon the movement of the machine,' etc.; and the fifth covers the cord arm, which, with the cord or twine, encircled the bundle, the cord paying off from a reel and through the end of the arm in the usual way, substantially. It shows two ways of fastening the band; one by passing the end of the cord through an eyelet which is closed down upon them by a blow from a plunger, the other by making a knot. Apparently everything necessary in the way of a binder was thought of, and much more, but it did not get beyond experiments."

"P. H. Watson and E. S. Renwick, two of the three inventors whose patent we have just described, were granted another patent on binders December 6, 1853. This is an exceedingly complicated invention, but its general form more nearly approaches the modern harvester and binder than any other of these early inventions. The grain was to fall upon revolving bands, and was to be carried up by a series of such bands into a sort of crib, in which it was to be bound and from which it was to be delivered upon the ground. The binding was to be done with cord or twine, tied with a knot, and all the movements were automatic. This also had several pages of variations and modifications added. It was a mass of ingenious but impracticable devices." ***** "These first three efforts were made with cord or twine as the material for binding."

"The next patent on binders was granted to J. E. Nesen, of New York, December 13, 1853. He employed an endless platform apron, having an intermittent motion for carrying the grain to the binder hooks, which compressed into bundles that were bound with straw bands. It was not an automatic binder, of course. George W. N. Yost, of Mississippi, January 1, 1856, obtained a patent on a machine for binding with a cord band, cut to right length, with a knot tied in one end. This knotted end was placed in a notch, and the other end went somewhere. A gathering and compressing apparatus swept along the platform, forming a bundle, around which the band was brought when its ends were tied by an attendant. W. E. Pagett, of Virginia, July 29, 1856, used metal strips prepared with hooks and rings in combination with slide and 'way' by which the bands were put around the bundle and hooked together. These three last described were not automatic, and they added nothing to advancement. The next machine showed decided progress. This was the invention of C. A. McPhitridge, of St. Louis, Missouri, by whom it was patented November 18, 1856. The theory of it is very well given in his claim substantially as follows: The combination of the reciprocating arm with spring pliers attached, with stationary arm, revolving twister, cutting plate, friction brake, spring and movable plate; when the same are constructed and arranged to operate in relation to each other and the main frame and driving wheel, for the purpose of binding

grain from a continuous coil of wire, etc.' "He was the first to bind with wire, which was coiled upon a reel and delivered to the reciprocating binding arm. The latter performed its functions substantially like the modern arm, and the wire received the ordinary twist and cut."

"During the year 1857 four binder patents were issued as follows:- April 28, to J. F. Barrett, New York; May 5, to H. Kellogg, Marengo, Illinois; September 22, to J. F. Black, Lancaster, Illinois, and December 29, to L. D. Phillipps, of Chicago. All were for improvements in, or aids to, hand binding with straw." ***** "During this same year the Marsh Brothers were inventing their harvester, and seeking the same end - rapid straw binding - but in another way altogether, their plan being to deliver the grain by the machine in the best possible condition and position to the attendant binders riding, leaving them to do the mere tying by hand, free from and undisturbed by the traps and aids proposed by others."

"Allen Sherwood, Auburn, New York, January 26, 1858, took out a patent, and September 14 another, covering devices in his wire binder. The first patent claims binding the grain by means of a wire, placed on a spool and carried partially around the grain by the arm, in connection with twisting and cutting devices; and the second claims - in combination with fingers for throwing the gathered gavel up into the concave - the arm for carrying the binding wire up and over the sheaf and placing the wire in the slot of the twisting wheel; also the combination of the sliding knife with the twisting wheel for cutting off the wire; the twisting wheel with the wire carriers; and finally, the 'forming a knot or enlargement on the end of the wire behind where it is cut off by the cutter, by twisting the portion of it,' for the purpose of preventing the end being drawn out of the slot in the twister. August 30, 1859, he took out another patent covering improvements in his machine. Sherwood's binder was very ingenious and did good work. It was intended for attachment to reapers of the time, hence was not fully automatic, but required an attendant to work it. He spent several years in developing and in trying to introduce it, and a considerable number were built and used, giving promise of ultimate success, but the prejudice of farmers against wire, and its high price, proved too much for him." ***** "He only failed because the conditions were too unfavorable."

"March 2, 1858, W. L. Childs, of New York, patented an ingenious twine-binder. The cord was taken from a spool located in the grain-wheel divider. It was passed under the platform and around in front of the receptacle into the nippers, above, in the arm; a self-rake swept the grain against the cord, which was forced back, receiving and encompassing the gavel; then the arm came down, the twine was cut off, and the ends were twisted and tucked under automatically. He also had a bundle carrier. March 23, a patent was issued to A. F. French, of Vermont, covering devices for aiding attendant to bind with straw bands, twisted by hand; May 11, to G. Notman, of Ohio, for a mechanism by which the binding was done with cords cut to lengths and placed by an attendant; July 6, to John P. Manny, of Rockford, Illinois, on a machine something like the last, for binding with a prepared cord band, cut to proper length, having a knot tied in one end, and a little cast hook on the other, placed in position by an attendant, but automatically passed around the compressed gavel - hook and knot engaging as bundle expanded when loosened from the compressor, the binding mechanism operating in combination 'with a rake that automatically throws itself out of gear,' etc."

"August 17" (1858) "C. W. and W. W. Marsh patented their hand-binding harvester, which, though not belonging specifically to this class, became finally the foundation upon which practical binders up to this time" (1894) "have been built. To J. Mitchell, September 7, was granted a patent for an automatic straw binder. 'This invention consists in the use of clamps or band-carriers, a band-twisting device,ucking rod, and discharging device applied to the reaper, arranged relatively with each other and operated, whereby the grain is bound into sheaves and discharged upon the ground, the whole working automatically as the machine moves along.' It was not practical. The next patent, November 16, was to William Gray, of Ohio, covering ingenious contrivances for binding automatically with straw. The idea was suggested to him by the peculiar automatic self-rake of Jearum Atkins, mentioned in review of reapers. 'Spring talons forked at ends and mounted on a turning post like Atkins' self-rake, are brought down to the gavel by cam slot in post; they descend so that one talon strikes the heads and the other the butts; their spring ends being forced into the grain pick up a wisp for a band; they then turn at right angles to the gavel, placing the wisp or band across it; descending further and coming together with band carried around the gavel, the ends of the bands are twisted by rotating pliers and tucked under; then the talons raise, lifting the bundle and dropping it upon the ground, and go back to place to repeat,' etc. One feature which is deserving of particular notice is described in first claim: 'The arrangement of gravitating platform,' ***** 'and the series of levers' ***** 'with their accessories, in the described connection with a drive-wheel, for the automatic starting of the binding mechanism by the weight of the sheaf or gavel,' that is, the weight of the sheaf threw the binder in gear."

"March 8, 1859, to A. Ralston, of Pennsylvania, a patent was issued on device for assisting attendant to bind with straw. It had a 'shocking carriage' attached, in which a shock was formed and dropped upon the ground through its bottom. To J. D. Osborn, of Michigan, June 14, a patent was issued for a twine-binder, of which the claim is as follows: 'A binding knot composed of three loops passed through each other, when said passing of the loops through each other is effected by machinery driven or moved from any of the moving parts of a harvesting machine, and whether accomplished by the means herein stated or by their substantial equivalents.' The cord or twine was taken from a reel. To F. Meyer, of Illinois, August 2, a patent was issued for a very ingenious and complicated series of devices by which a straw rope band was twisted from the butt of the gavel and wound around the latter while being turned or rotated for the purpose. To C. H. McAller, of Wisconsin, August 16, a patent was issued for devices to aid attendant in binding with straw by hand, and October 11, to J. McAller for improvements on the same. To C. H. Durkee, of Wisconsin, November 22, a patent was issued for mechanism arranged to assist attendant in binding with straw bands, cut and prepared."

"In 1860, May 22, a patent was issued to D. W. Ayers, of Illinois, for a wire-binder, having a rotating arm, twisting device, cutter and holder, 'all the parts working automatically by the turning of a shaft, and a gavel bound at each revolution of the shaft.' To H. Kaller, of Illinois, June 5, a patent was issued for a wire-binder with a vibrating curved arm, and means for cutting and twisting the wire; and to A. B. Smith, of Pennsylvania, June 19, for cord binder, the chief feature being

its compressing arms, working independently of the cord arm, etc."

"June 26" (1860) "W. W. Burson, of Illinois, obtained his first patent. This was for a twine-binder, to be used upon any reaper, and to be operated by an attendant. It tied a knot in the cord by means of hooks working together. July 10 a patent was granted to J. Courser, of Illinois, for an automatic knot-tying device for taking twine from a reel; on the 17th of the same month to J. S. Hickey, of Illinois, for a binder to be operated by hand, and to Charles Marston, of Wisconsin, August 14, for a very cumbersome and complicated machine for binding and shocking, and devices to aid attendants riding to bind with straw braid."

"In 1861, February 12, a patent was issued to S. Reynolds, of Rhode Island, for a wire-binder with arm, twister and cutter, operating automatically; to L. P. Harris, of Ohio, February 26, for another wire-binder, which discovers nothing new. W. W. Burson" ***** "took out a patent on the same date," ***** "for his wire-binder, and it was the foundation of a machine that made more stir, and came nearer to practical success and public approval than any other of the various binders belonging to the first era. It was constructed as an attachment to the ordinary reaper. As the gavels were raked into the binder an attendant sitting beside it turned a crank giving the necessary movements for binding the bundles. Other patents for improvements were issued to him as follows:- To H. M. and W. W. Burson, March 3, 1863; to W. W. Burson, August 11, 1863; also October 4, 1864, and July 25, 1865, the two latter patents covering devices for adapting his binder to the use of twine. Burson's first binder, built in 1859, patented June 26, 1860," ***** "bound with twine, but as that material was not easily obtained he turned his attention to wire. He had two wire-binders at work in the harvest of 1860. The next year some twenty-five of them were built at Muscatine, Iowa, for attachment to the John H. Manny reaper, and were worked in the harvest from Vandalia, Illinois, northward as far as Red Wing, Minnesota, several being sold to farmers. In 1862 about fifty more were made. One of them was at the great reaper trial at Dixon, Illinois, that year. It made a decided sensation." ***** "It was used on a John H. Manny six-foot-cut reaper, made by Talcott, Emerson & Co., of Rockford, Illinois. Burson arranged with this firm to build for him 1,100 of his binders for 1863. ***** A profitable market could not be established for them, so their manufacture was discontinued. Yielding to the objections against wire he turned again to twine-inventing and substituted a knotter in place of his wire twister, and he had this in successful operation in 1865."

A patent was granted October 29, 1861, to C. Alvord, of Wisconsin, for "reciprocating gavel carriers, presses, etc.; to C. Powers and P. Lancaster of Michigan, October 29, for a twine-binding attachment which had considerable merit, its chief feature being a rotating head in connection with a swinging arm. The ends of the cord were held by a tight twist."

On April 15, 1862, a patent was issued to A. S. Harding, of New York, "for a machine to rake and bind grain with straw taken automatically from a box, put around gavel and ends twisted, clamps and other devices helping in the operation;" a patent for another straw-binding machine was issued "to J. H. and A. E. Rodstone, of Indiana, August 19, for rake and straw-binding devices; and to J. M. Grosh, of Pennsylvania, October 28 for something of the same general character."

A patent was issued January 13, 1863, to T. Palmer, of New York, "for an automatic twine-binder. The grain was drawn from a slotted platform by a reciprocating rake, when it was caught by a cradle and delivered to hooks, clamped and bound by a series of operations and devices. To R. D. Brown, of Indiana, April 7, a patent was issued for a complicated machine which in addition to binding the sheaves, deposited them in bunches on the ground, and had a device for counting the number thus dropped; to W. H. Harrah and H. P. Jones, of Iowa, June 30, for a wire-binding attachment operated by an attendant; to J. Judevine and Z. Shaw, of Wisconsin, July 14, for a similar wire-binding attachment; to A. B. Smith, of Pennsylvania, July 28, for improvements on his twine-binder, first patented June 19, 1860; to A. Underwood, of Wisconsin, August 11, for a very ingenious automatic twine-binding attachment, which was constructed on its own platform, taking the place of the reaper platform when attached, and forming thus a complete machine (the cord was twisted and then tied, and an automatic fork discharged the bundles) to W. D. Harrah, of Iowa, December 22, for a novel binding mechanism, the gavel of grain being pressed endwise into a compressing tube on which were prepared endless bands, one of which was slipped over the sheaf as it passed out of the tube, the expansion of the bundle tightening the band around it."

On January 26, 1864, "S. T. Holly took out two patents on binder." *****
"On February 16, 1864, Jacob Behel obtained a patent "for one of the most important inventions ever made on binders, viz.: the knotting bill and turning cord holder. The bill, which was substantially like all in use now," (1894) "seized the portions of the cord which were to form the knot, and looping the same, moved back past the knife, which severed the cord at the proper point, leaving the end of the cord from the reel (or ball) firmly held by the turning cord wheel. Mr. Behel, in connection with W. Hedges, took out another patent September 6, which has, among various claims, one for an adjustable cord guide located between reel (or ball) and binding arm, and his patent of September 19, 1865, claims a friction apparatus, swinging frame and cord guides, for the cord as taken from the spool (or ball), also the combination of tying bill and moving knife. Mr. Behel was a meritorious inventor, but" ***** "he was too early, for when the time came for all the world to use his inventions his patents had nearly all expired."

A patent for a wire-binder "having several ingenious and important features - a rack for giving motion to twister, etc.," - was issued to "S. J. Wallace, of Illinois, April 12, 1864." ***** "T. T. Curtis, of Michigan, May 3, patented a machine that combined a self-rake, binder and shocker."

According to Ardrey this brings the record on binder patents down to 1865, and "here ended with Burson's final effort, all hope on the part of practical men of establishing a marketable self-binder with conditions as they were, i. e., with material for binding so dear; with the difficulties in the way of making any binder work in connection with a reaper or on the 'low-down' principle; and with the Marsh harvester on the market then as a successful competitor on the score of economy against any binder, no matter how thoroughly practical in operation it might have been."

Several binder patents were issued in 1865, two of which were granted to S. D. Locke, of Janesville, Wisconsin, on December 19, "one covering a compressing device; the other his rotating hook twister." Locke is said to have begun a binder in 1861, but never completed it. "From this commencement to 1869 he was engaged in efforts to adapt binders to reapers, working

on different plans, and taking out various patents. In the Spring of 1869 he arranged with Walter A. Wood & Co., of Hoosick Falls, New York, and went there. He tried first to fit his binder to the Wood self-raker; but gave that up, and then put one on a heading machine, operating it with fair success in 1870. The Company built several for these headers the next year. In 1872 he attached one, as he says, to 'a harvester of the modern or Marsh type.' They built five on this plan in 1873, of which four were used for that harvest. Next year a few more were built, and the next three hundred, and after that they were put upon the market in large numbers by the Wood Company, up to 1880, inclusive."

"Mr. Locke took out patents too numerous to mention. He claims to be the first man to build an automatic binder as a distinct and separate machine for attachment to a harvester." ***** "While it is probably true that Mr. Locke was the first inventor of binders on record who made a final success, and that success began with the adaptation of his binder to the Marsh harvester in 1872, yet to S. D. Carpenter, of Carthage, Missouri, then of Madison, Wisconsin, probably belongs the credit of the first attempt of the kind. Carpenter seems to have been the first to discover this necessity to binders - the elevation and then downward delivery of the flowing stream. He began his binder work back in 1861 or 1862, in the usual way for attachment to reapers; and although there is some dispute or discrepancy as to dates, he certainly had a binder on a Marsh harvester as early as 1867. His machine created considerable of a sensation, was successfully exhibited, and a number experimentally built, but they did not get it upon the market."

"James F." (Gordon) "began inventing in this line as early as 1862, and had a full-sized machine in 1864. He continued his experiments under adverse conditions - lack of means, and other disadvantages - getting a second machine built in Kalamazoo, Michigan, in 1867, and another in Rochester, New York, in 1868, which was successfully operated near that city and elsewhere during harvest. May 12 of that year his first patent was issued." ***** "He built several for the next season which were used in the field, and exhibited at Fairs - but success was not assured until 1871, when he procured a Marsh harvester and attached his binder thereto, with which new combination he did good work that harvest. He continued on this last plan, assisted by his brother, John H. through 1872 and 1873, building, perfecting and exhibiting their binders as attached to harvesters. August 27, 1872, he obtained a patent on an improved machine, and June 16, 1874, on another. On account of peculiar construction one of these early binders was designated the 'gaveler' and the other as the 'reciprocator.' John H. Gordon, then living in Kalamazoo, Michigan, built his first 'packer' binder during the Fall of 1873, and prior to the next harvest three were completed for the market. He bought three Marsh harvesters upon which to place them. One of the machines thus combined he sold" ***** "for \$300. cash. This is believed to be the first cash sale of an automatic binder on record. It did excellent work and bound about one hundred acres. Gammon, Deering & Steward became interested in Gordon binders in 1873, and in 1874 began putting them on the market. J. F. Gordon produced soon after what was known as his 'crane' binder, which was built largely by Gammon, Deering & Steward. D. M. Osborne & Co., also built this, taking license from both the brothers on their machines, and D. M. Osborne afterward bought an interest in their patents. J. H. Gordon next invented his 'crank and guide-

arm,' or the Buckeye wire binder - so-called after this concern took license and began building. This was in 1878. The next year Walter A. Wood & Co. took a license on this last machine as improved, and made a couple of hundred before they changed to twine. Having thus brought their several wire-binders to a high state of perfection" ***** "with several of the largest manufacturers as their licensees, building thousands annually, the world seemed fairly in their grasp, when suddenly the twine binders surged to the front and captured the whole trade."

"Along in the early part of the 'seventies' several ingenious binding machines were patented by various inventors. W. H. Payne began them and continued thereafter with varying success, until the Appleby swept him and others out of the market. It is said that he was the first to use a bundle carrier with a binder. There were Spaulding with his measuring or trip device; Barta, Chapman and Fowler, with his ingenious mechanism for stitching a band around and into a bundle. Keller and Storle did good work, and so did Travis and J. F. Steward later. John H. Whitney patented his binder, low down, in 1870 and 1872, and was making rapid strides toward success; but his fire was too intense and he soon burned out, dying in 1872."

"So much misfortune had all along befallen these various efforts to attach binders to reapers, that the attention of inventors about that time became directed to another method of gathering and binding the grain, resulting in the peculiar machine called the 'gleaner' which is a binder attached to a raking device for gathering gavels, deposited on the ground from a reaper, and binding them. A patent was granted to M. T. Ridout, November 14, 1871, for the first gleaner. Other patents were issued on this style of machine to J. A. Scott, in 1873, Leuz and Wittker in 1874, and afterwards to R. Eickmeyer, M. G. Hubbard, Samuel Johnson, W. N. Whitely and others. Many of them were built and used successfully, especially in the Eastern and Middle States."

Marquis L. Gorham, of Illinois, "began on his binder in 1873, and had it done for the harvest of 1874. He attached it to an 'altered over Marsh harvester.' This machine did good work in the harvest of 1874, cutting and binding many acres. Mr. Gorham obtained patents on it February 9, and March 16, 1875. He continued his experiments, making improvements and applying for patents thereon until sickness intervened, and finally death in the Fall of 1876, brought to rest his overtaxed body and brain. Some efforts were made to finish his work, but" ***** "it was not pushed forward with sufficient promptitude to obtain a place before the Appleby had captured the market on this style of machine. Mr. Gorham" ***** "added much to the perfection of farm implements."

"The St. Paul Harvester Works, of St. Paul, Minnesota, did a large amount of pioneer work. They were among the first to build, exhibit and put upon the market modern cord-binders, under the Ellward and Levalley patents. The binder operated fairly well, and they were gaining ground with it until the Appleby and Holmes stepped in before and demolished them."

"Charles B. Withington, of Janesville, Wisconsin, patented February 20, 1872, and May 19, 1874, one of the best and most successful wire-binders ever put in the field, as attached to the Marsh harvester manufactured by C. H. and L. J. McCormick & Co. This binder differed essentially from the Gordon and other wire-binders, in its chain movement, in carrying two spools of wire from which the bands were formed, and in other operating devices.

In 1874 or early in 1875, Withington sold a half interest in his patents to the McCormicks and made general arrangements with them for the development and manufacture of his machines. They built three or four experimental binders for 1875; thirty or forty in 1876, and in 1877 they were put regularly upon the market, where they held a foremost place until 1881, when the McCormicks began building the Appleby." (8, p. 65-77)

An interesting story regarding the Withington binder is related as follows:- "In 1874 came the first hint of the 'self-binder.' A man named Withington, watchmaker by trade, came from Janesville, Wisconsin, to explain a device for binding bundles automatically with wire. A curious twist of the story is that McCormick, being very tired, fell asleep while Withington was explaining the device, and the inventor, leaving the manufacturer asleep, took his device up sadly and went home. McCormick awoke with a start to find the man gone, remembered part of what he had seen, and the next day sent a man to Janesville to bring Withington and his device back to Chicago. The device was put into service, and the first demonstration of the self-binder was held on a farm near Elgin, Illinois, in July, 1875. For five years this binder, using wire, was the leader among harvesters. But the wire was objectionable, and when a man named Deering, in 1880, brought out a twine-binder he sold 3,000 of them as fast as they could be supplied. The next year McCormick came out with an improved twine-binder." ***** "The rapidity with which harvesting machines were taking hold may be seen from the fact that in 1880 the total of all machines sold was 60,000, while in 1885 the total was 250,000." (23, p. 4)

John F. Appleby "took out patent for binder as far back as 1868. He worked and experimented for many years, and unquestionably built a number of experimental binders - at first on the low-down or platform plan" ***** About 1873 or 1874 "he began applying his principles of binding to the Marsh harvester." ***** "Four machines were made by Parker & Stone, of Beloit, for 1878." ***** "In 1880 there were perhaps 3,000 of them on the market." (2, p. 13)

"In reducing the cost of producing a bushel of wheat from three hours and forty minutes of man-labor in 1830 to ten minutes in 1880, the twine knotter was probably the biggest factor. The wire-binder was developed by Appleby, Withington, and others from 1858 to 1878. During those twenty years Joseph Barta, of Bangor, Wisconsin, and some others, were nursing the germ of the twine knotter. It is Barta, in La Crosse County," (Wisconsin) "who is to be credited with a patent for the first successful twine knotter." ***** "John F. Appleby had played with a twine knotter as early as 1857, when he made a bird-bill knotter out of apple-tree wood on the Houghton farm near Whitewater, Wisconsin. The next year he made a similar one out of steel in a Beloit gun shop. This knotter is now in the Museum of the Wisconsin Historical Society. Appleby exhibited it as a sort of curiosity rather than a substantial invention, at County Fairs during the late fifties and early sixties. It is significant that the tablet placed on the Houghton farm in October, 1926, reads: 'On this farm John F. Appleby made the first knotter in 1858.' He never patented it. Apparently he deemed it not worth the trouble. Not so with Barta. He began tinkering

with a sewing machine at Hillsboro, Wisconsin, in 1855, in an effort to make a binder out of it. The sewing machine could sew a stitch. Why couldn't it tie a knot? Barta carried the sewing machine idea with him when about 1860 he moved to Bangor. Instead of going on a tangent with the wire binder, as Appleby did, Barta stuck to twine. By 1866, with four friends to back him to the extent of about \$10,000. he had attached a basket and knotter to a McCormick reaper. It was patented May 15, 1866." ***** "It did satisfactory work that year with a light stand of grain, but did not work so well in the fields with heavier straw. Florian Wolf, of Bangor, drove the reaper." ***** "Two of Barta's bankers were John Husa and Michael Arentz. The latter was so sure of financial success that he bought Husa out. The bargain was made in an oatfield in 1866, when Arentz agreed to give Husa, a bachelor, seven quarts of milk, one pound of butter, two loaves of bread and a dozen eggs each week so long as Husa lived. The weekly meal ticket was later consolidated into an annual cash payment of \$75.00, which was paid September 1, each year by Arentz, or his heirs, until Husa died in 1908. Husa's bargain proved to be the shrewdest financial move made by anyone connected with the Barta knotter. By 1872 several Bangor and La Crosse men had invested from a thousand to ten thousand dollars apiece in the venture. About thirty farmers bought fifty-dollar shares. Their hopes of success were high in July, 1872, when Barta's second knotter, this one of the revolving type, made a successful demonstration. It was protected by a second patent, but within six months, and after only fifteen of the improved knotters had been made by the Paul and Leach Threshing Machine Company, at La Crosse, a competitor had entered the field. The latter was not wholly successful, but nevertheless put Barta out of the race."

"By 1878 Appleby had discarded the wire binder popularized by Cyrus McCormick, and turned his attention once more to his twine knotter. It was he, rather than Barta, who became William Deering's partner in 1880. Together they startled the country with 3,000 twine binders and ten carloads of suitable twine that had been manufactured secretly by Deering."

"Two of Barta's knotters are in a showcase in the Agricultural Engineering Building on the campus of the University of Wisconsin. One is the original stitching knotter; the other is one of the later type." ***** "A shadow of Barta's effort was seen one autumn afternoon in 1879, when a mysterious stranger appeared at Ott's machine shop in La Crosse, and paid Benedict Ott, one of Barta's stockholders, \$500. for a quitclaim to his share of Barta's patents. It is rumored that others also were paid sums of money, but these other claims have not been verified. Unverified, they form links in a chain of evidence which indicates that someone, great or small, deemed it wise to make a pretense at least of buying out the patent claims of Barta." (19, p. 227)

An interesting statement in (5, p. 19) is quoted from Farm Implement News of August 4, 1892, as follows:- "Bentley & Gerwig of New Brighton, Pennsylvania, made the first twine for use in a twine-binding harvester." (5, p. 19)

According to Ardrey, one of the best known inventors in the line of harvesting machines was John F. Appleby, and "no machine ever swept over the world with such overwhelming rapidity.- once it got started - as the twine-binder designated the 'Appleby.' This success was not due to the

newsness of the devices applied, nor to the surpassing character of Mr. Appleby's genius, although he has been a persistent and clear-headed inventor, but it would seem that the ingenuity of a number of inventors, running in the same direction, had become massed or dammed before certain common obstructions, beyond which they could not flow; and it was reserved for him to combine in his binder - built upon the Marsh harvester - the most practical of these principles, directing the best efforts into one channel; and by devices of his own to remove the obstructions, thus opening the way for the flood that followed."

"In the Fall of 1881 W. N. Whitely, then the head of the Champion interest at Springfield, Ohio, who had been experimenting largely with low-down and other binders since 1875, bought the interest of Appleby and his assignees in his many patents. Others had obtained licenses or shop rights, or arranged with Whitely therefor. So from that time and onward the twenty odd manufacturers of the United States have been running substantially in one groove, building the Appleby type of binders upon the Marsh type of harvesters, each applying special or distinctive devices in accordance with his bent, the Holmes binder only, built by the Walter A. Wood company, differing from the others in some of its principles. Mr. Holmes, the inventor, began experimenting in this direction as long ago as 1868, it is said." ***** "His patent was granted December 3, 1878." (8, p. 77)

At the beginning of the twentieth century the facts relating to grain harvesting machinery other than combined harvester-threshers, in the United States was summarized by the Census Office, U. S. Department of the Interior as follows: "The perfected grain harvester, or harvester and binder of today, is a machine constructed in nearly all its parts of iron and steel. It is of the utmost lightness consistent with strength and qualities of endurance, and has wide wheels and improved axle bearings to lighten the draft; adjustable cutting apparatus, grain wheel and divider to separate the standing from the cut grain, raising and lowering mechanism for adjusting the machine; a reel perfect in its operation for depositing the grain on the platform; an elevator for conducting the grain from the platform to the automatic binder, and an automatic twine binder successful in its action, in binding the grain compactly in sheaves or bundles of uniform size. The automatic self-binder, invented by John F. Appleby, seems to have been the culminating improvement made in grain-harvesting machines, and is used in one form or another, as an attachment to the harvester to bind by far the largest part of the grain harvested in this and other countries." (29, p. 362)

The binder represents possibly as great an advance in harvesting machinery as the reaper, yet the binder was hardly out of the experimental stage before developments occurred which foreshadowed its replacement. The successor to the binder appears to be the combine, - a machine which cuts, threshes and cleans the grain in one operation.

Combined Harvester-Thresher

The so-called header-thresher, harvester-thresher, or more commonly referred to as the "Combine" - a machine that cuts, threshes, and cleans grain at the same times - has been called the "Once over and its all over" machine.

"The idea of combining the operations of cutting and threshing grain so that both are done at the same time by one machine is not new. On the contrary it seems to have occurred to at least one individual nearly one hundred years ago. The United States Patent Office shows a patent on a combined harvester as early as August 8, 1828." (21, p. 100)

The combined harvester-thresher patent dated August 8, 1828, was issued to Samuel Lane, of Hallowell, Maine, according to the Records. "There is no record of his building any machine and actually combining grain with it." (4, p. 30)

"E. Briggs and C. G. Carpenter, February 6, 1836, patented a machine that ran on four wheels, like wagon wheels, and depended upon the traction of the two hind wheels to carry both the cutting and threshing apparatus. They claimed broadly 'the manner and principle of applying the power of a team to cutting, threshing and cleaning grain by moving forward the machine,' etc., but this was not a new idea."

"June 28, 1836, H. Moore and J. Hascall, of Kalamazoo, Michigan, patented a machine for harvesting, threshing, cleaning and bagging grain, which deserves particular mention because of its many ingenious devices, its comparative success and the notoriety it gained on account of the unsuccessful attempt made in 1853 to get the patent extended through Congress." ***** "This machine had a reciprocating sickle, working across fixed guard teeth, with a 'rippling cylinder,' studded with rows of small spikes, acting as a gathering reel over the sickle, and delivering the grain upon an endless apron behind, which carried the heads back to a threshing cylinder. Back of the latter was a traveling sieve, or riddle, which carried the coarser refuse over to fall upon the ground, while the threshed grain and chaff, sifting through the sieve, was winnowed by a fan blast, then elevated and delivered through a spout into bags." (8, p. 54-55)

"It appears that this machine" (the Moore and Hascall) "harvested and threshed grain in an acceptable manner, but its use in Michigan was abandoned on account of climatic conditions, and the difficulty in preventing the threshed grain from spoiling. Records indicate that this machine was shipped to California, via Cape Horn, where it was used in harvesting grain first in 1854. The process of cutting and threshing grain in one operation was further improved and developed in California, and has been rather common there since about 1880." (20, p. 3)

The story of the invention of the Moore and Hascall machine is so unusual and interesting that it is related here, considerably condensed, but with the main facts substantially as told by F. Hal Higgins, in Michigan History Magazine, v. 14, (summer number) 1930, p. 415-437.

In the article by Mr. Higgins (p. 415) appears the following:- "His" (Andrew Y. Moore) "three letters to the Michigan Farmer and the Pacific Rural Press in 1846 and 1886, respectively, are the best bits of history we have on this early combined harvester, and its migration from Michigan to California. From them the writer has been able to dig out of the California, Michigan, New York, Wisconsin and Illinois libraries, as well as from the third generation of the A. Y. Moore family, a history of the combined harvester, as dramatic and colorful a story as the gold rush the machine followed to California." (15, p. 415)

In (27, p. 237) appears the statement that "Andrew Y. Moore who appears to have been a Michigan neighbor of Hiram" (Moore) "but not a relative."

Mr. Higgins includes in his story a statement by A. Y. Moore said to have been published in the Pacific Rural Press under date of August 31, 1889, which statement forms the basis of the story related here. The Patent Office application of Moore and Hascall is also given in the Higgins article. (15, p. 431-437.)

Mr. Hascall was a lawyer who moved from the East to Kalamazoo, Michigan, probably about 1820. Apparently he had little, if any, legal practice, and he decided to try to raise wheat near Prairie Ronde, Kalamazoo County, Michigan. "He knew he could not harvest it, and there were no men to hire. He spoke of it in the family, and in consequence it caused his wife to dream." Mrs. Hascall related this dream to her husband. In her dream she saw "A large machine going over the prairie drawn by horses and harvesting wheat, and described its motion and appearance." Knowing Hiram Moore, of Climax Prairie, Michigan, to be of an inventive turn of mind, Mr. Hascall related the dream to him. "Hiram asked how he would have it operate. Mr. Hascall replied, holding out his hand with fingers extended, he would run it through the grain, and with the other hand draw over and backward, he would cut it like that." About six months later, during which time - as the story goes - the dream having bothered Mr. Moore somewhat, he decided to "put his mind seriously upon it," with the result that he "made a model and took it to Washington City, exhibited it at the Patent Office, and obtained a patent. This was in the year 1834." The author of the article cited states that "Patent not officially granted till 1836, but undoubtedly Mr. Moore's dates are correct, as the Patent Office was in its infancy then." (15, p. 418) This supposition is further supported by the copy of the Patent Office Application, a copy of which is given on pages 431-437 of last reference cited, which gives the application date as June 28, 1836.

Before harvest in 1835, a temporary machine had been built by Hiram Moore at Flowerfield, Michigan, and it was tried out in the field that year. The machine was not complete, however, the thresher not being in place, and the trial being for the purpose of testing the cutting apparatus. After cutting about two rods something broke. This probably ended the trial. "In the failure he said: 'I see the shore afar off, and it will take a long time to get there, but I will succeed in time.'" Later another model was constructed and tried out. "The harvester cut it and threshed it" (the grain) "in good order" but the machine was still incomplete, as the cleaner was missing. "Twelve horses were worked on the machine at that time, besides the team hauling to the barn." The cost for cutting the three acres

used in the experiment averaged 82¢ per acre, as compared with about \$3.12 per acre when harvested by the common method of "cradling, raking and binding, shocking, staking, threshing, cleaning, etc." ***** "By the harvest of 1837 it cut only 20 acres" and it was found that "it wanted further perfection, although the threshing and cleaning" (apparatus) "had been added." ***** "In 1841 he" (Hiram Moore) "invented the Angle Edge sickle," seemingly a rather remarkable device, as it was claimed "it would work all through harvest without being ground when first in good order. The first sickle was straight, with teeth cut in sections each way. In the fall of 1841 Mr. Moore went to Rochester, New York, and procured good mechanics, and he completed two machines." One of these machines was used "for the harvest of 1842." (15, p. 418-419)

The story continues to the effect that A. Y. Moore had the only complete machine built for himself in 1843. "It was drawn by sixteen horses, hitched two abreast, walking by the side of the grain, cutting ten feet wide, threshing, cleaning and bagging the same, doing 25 acres in a day." It is further related that Mr. Moore "ran it" (this machine) "every season till the harvest of 1853," when George Leland purchased an interest in it. The owners "shipped it to California the same year," (where) "it cut over 600 acres" ***** "in Alameda County, in 1854." It was not used in 1855, but was started in 1856. Owing to lack of proper lubrication "it took fire and burned in the field." (15, p. 419-420)

"Several of the Moore-Hascall harvesters were built in Michigan, one of these," ***** "being in California by 1854, there to become the progenitor of the swarm of combines later used throughout the dry land wheat belt of the Pacific States. For years they could be seen, during every harvest season, with as many as forty horses or mules for power, oscillating over the volcanic ash wheat hills of the Palouse, the Umatilla, Sacramento, and San Joaquin. In recent years powerful tractors have supplanted animal power, but although the mounted, motor-driven combine has invaded the field, the ground powered combine is still found - a Moore-Hascall machine, improved and modernized."

"As to Hiram Moore's place in the history of agricultural machinery, there can be no question. Regardless of the outcome of the reaper battles of the forties, fifties and sixties, the ponderous Hiram Moore machines were cutting wheat in Michigan's 'bread basket of the world' on a custom basis of 50 much per acre in the thirties and forties before the reaper appeared." (27, p. 242-243.)

Another interesting item relating to the Hiram Moore combine, has been found in (30, p. 20) which reads substantially as follows:- Ephraim Craig, of Orlando, Florida, "it seems was one of about a score of men - neighbors of the inventor - who witnessed the try-out of that pioneer harvester-thresher, on a farm near Climax, Michigan, in 1842." Mr. Craig believes he was probably the youngest of the group who saw the combine trial, and although an elderly man at the time the above mentioned article was written, his recollection of the machine seems very clear. He states that he "saw it work on its initial field tryout in 1842. The knife cut a 15-foot swath, and the threshed grain was delivered in two-bushel bags faster than one man could tie their tops, or two teams haul it to the farm granary. As the twenty horses hauled the immense wooden structure

around the field the cut heads were delivered direct to the threshing cylinders. The grain and chaff ran over shakers and screens; the grain falling into conveyors which delivered it into bags on a small platform on the side, while the chaff and straw were blown and raked out at the rear, and left in a trail on the stubble behind." ***** "Twenty horses were required to draw the machine when it was in operation." Mr. Craig states that "it was operated during its first season in 'my' section of southern Michigan, but the next season Moore took it into a country northeast of 'me.' ***** Mr. Craig states that he never saw the machine, nor its inventor, after this move, although he heard of its being used several seasons - more than one anyway. (30, p. 20)

That Mr. Moore was not the only man interested in producing a combined harvester-thresher in the third decade of the nineteenth century seems to be proven by the following statement: - "Combined harvesters actually were built and harvested grain in the thirties. One of these was made by a man named Williams, in Canada, who apparently took out no patent. While his machine did combine grain, he ran into so many mechanical problems that he became discouraged and lost interest. One trouble with his machine was the difficulty in steering. Humidity during harvest was undoubtedly a factor that led him to drop the idea, just as it was of all others at this time." (4, p. 30-31)

Following the invention of the Moore and Hascall combine in this country other American inventors devised various machines for harvesting, threshing and cleaning grain in one operation. One of the early machines "was invented by Alfred Churchill, of Geneva, Illinois, and patented March 16, 1841." Apparently "it was constructed on an entirely different principle" from those which had preceded it, "but it does not appear that it ever went into use."

"May 14, 1841, D. A. Church, of New York, obtained a patent for still another harvester and thresher. The peculiar feature of this was that it had the old Gallic comb cutters, improved by having a spring attached to keep them up to the gathering wheel, which latter operated, like the old 'rippling cylinder,' to force the heads against and between the knives. The heads, after being dissevered, were carried back, threshed and delivered in substantially the usual manner. Some of these machines were manufactured for the market, and gave, it is claimed, good satisfaction. February 13, 1837, Mr. Church, in connection with L. H. Overt, of New York, and W. W. and O. F. Willoughby, of Chicago, patented certain improvements in the construction of a separator, consisting of 'separate combs turning on pivots in endless chains', etc. Mr. Church died about this time. E. C. West, of Vermont June 25, 1845, patented a sort of revolving cradle apparatus for cutting, with apron to receive grain and to deliver to threshers. March 7, 1846, J. Darling, of Michigan, patented improvements upon carrying platforms formed of toothed slats, and moving as described to convey grain to the thresher. He also claimed a mode of steering by pivot wheels. Clinton Foster, of Indiana, January 1, 1847, patented devices relating to machines of this description."

"D. J. Marvin, of California, November 15, 1864, obtained a patent for a harvester and thresher, 'so pivoting or hanging cutter frame upon the main axle that it can be moved longitudinally, and also raised and

lowered at pleasure,' etc." ***** "M. Vanderpool, Oregon, October 6, 1868, on peculiar harvester and thresher, with spiral reel, obliquely ribbed drum, ribbed concaves and spiked drums, etc.; L. B. Lathrop, California, May 25, 1869, on a harvester and thresher with too many devices to describe herein." (8, p. 55, 61)

"The combine in America appears to have gotten its real start in California, no doubt due to the fact that climatic conditions in that State were particularly favorable to successful combine operation, and wheat growing was a more or less prominent industry. As early as 1867 we find that D. C. Matteson built a combine at Stockton, and that patents were granted to several residents of the States of California and Oregon in the early sixties. A few years later, in the early seventies, several men on the Pacific coast were apparently alive to the possibilities of the combine, and began to incorporate their ideas into actual machines. By 1887 several machines were scattered over the State of California, and by 1890 several concerns" ***** "were in production, and ready to meet the requirements of the Pacific coast wheat growers."

"These early machines differed little in principle from the combine in use today." (1929) "Wood construction, which was vogue at that time, was used. This material made the machines very cumbersome, which was further augmented by the fact that the idea of the early combine manufacturer was to get as much capacity as possible out of a single unit. Machines cutting a swath 30 feet wide, or even wider, were constructed, and as their weight ran up to 15 tons or more it required as many as 40 horses or mules to pull them, especially where the land was rolling. To meet the hilly conditions of Washington it became necessary to develop a levelling device, which would compensate for the unevenness of the fields. This gave rise to what is now known as the 'hillside' as against the 'prairie' type of combine. The 'hillside' type of combine is still operated largely by horses because of the fact that it is very difficult to operate tractors on such steep grades. Steam power, was, however, applied to the combine in the early nineties, and a few years later an auxiliary steam engine was mounted on the combine as a means of direct power, thus insuring constant combine speed regardless of the speed of forward travel - a thing that has proven to be very essential to successful combine operation." ***** "By 1912 gas power began to slowly replace steam both as a means of operating the combine, and as a means of propelling it forward." (14, p. 8)

C. C. Johnson is authority for the statement that "The first successful combine harvester was produced in California in the early seventies, although the idea of this method had been growing from much earlier times. In 1890 several makes of machines were ready which were adaptable to the plains areas of California. These were not satisfactory for eastern Washington, where many hillsides were as steep as 60 percent. It was necessary to build the machine differently, and to level it to operate successfully under these conditions. The principal characteristics of these altered machines were the extensive use of 'riddle rakes' in the separating part of the machines, with a liberal number of fans to help move the straw, and the leveling device." (18, p. 26)

One of the early machines sold in Washington had "a leveling device operated by a chain which operated over a sprocket in such a way that one

side of the machine was raised while the other was lowered." Another make "used a crank axle for the main wheels instead of the more common swing-frame construction." One manufacturer produced "a combine which leveled on one side only." One inventor "designed a harvester using a special separating principle consisting of fans working under a raddle rake. He used the crank axle construction." Another machine was of wood frame construction, "capable of leveling on extreme hillsides, and making use of wind extensively in separating." An all-steel machine was built in Washington about 1914. "It used a cranked axle leveling device, and was motor driven. In 1915 a push harvester making use of a rubber cylinder" was brought out. Only a few were built, and they were not marketed, as it was found that they would not work as push harvesters due to the heavy draft." Two types of hillside combines have been developed - the "medium hillside model which levels to around 45 percent, and the extreme hillside type which levels to between 60 and 70 percent." (18, p. 26)

From 1882 to 1892 combined harvesters were built on the Pacific Coast by about a dozen manufacturers. Many of them "were successful in the field, all using the 'rotary system' of separation, and differing mainly in the method of taking the power from the main wheels and transmitting this to the cylinder and the separator. Early machines used the tight gear method, taking the power from a master gear on the main wheel, thence by pinions and countershafts to the cylinder, and on the reverse side from the cylinder shaft by gears to the separator. This drive was very expensive in the cost of repairs as gears wore out rapidly, and all machines were pulled by horses, and runaways were frequent. Of course when a runaway occurred it wrecked a tight-gear machine." ***** "In 1885" ***** one manufacturer "put out several harvesters for the first time using a link and V-belt type of drive. These first machines showed they had found the right idea." (7, p. 266)

The authority just cited goes on to state that during the eighties and nineties several contracting outfits using combined harvesters appeared. The expert operators of these machines held contests, and became famous in California, while some of them became associated with some of the older manufacturers. (7, p. 266)

"The first small combine put on the market was manufactured early in the present century. In 1905 this small horse-drawn combine, which cut a 7-foot swath, was manufactured in Idaho." ***** "A little later other small combines were manufactured. These machines were used only in the far West. The later small prairie-type combine, equipped with an auxiliary engine and pulled by horses or a tractor, was introduced in 1918." (25, p. 3)

"Before the advent of the small harvester-thresher, harvesting the 'combine' way was done only by huge machines cutting swaths of 25 feet to 40 feet, which required so many horses, or so much tractor power, that they were limited in use to very large farming operations." ***** "The light weight harvester-thresher" ***** "was placed on the market in this country in 1915. These first machines were horse driven, and the power for operating the cutting and threshing mechanism was obtained from the bull wheel, hence the term 'ground-driven.' A notable improvement brought about since that time is a positive drive provided for the cutting and threshing mechanism, by a four-cylinder gasoline motor mounted on the machine." (3, p. 22)

"Combines with a 9-foot or 10-foot cut, drawn by a tractor with a direct power drive from the tractor, were introduced in 1926." ***** Another "type of combine, also introduced in 1926, is mounted on the tractor, from which it obtains its power." ***** "This machines has an 8-foot cutter bar located directly in front of the tractor, and differs radically from all others in that an augur is used instead of canvases on the cutting platform. These small power-driven machines are used mostly on farms which have small acreages of grain." (22, 6-7)

"Combines may be obtained in sizes ranging from a 5- to a 35-foot cut." (1936) "Machines with a 10-foot cut or larger, with some exceptions, are available in either the hillside or level-land types. The hillside machines are equipped with brakes, and a device for leveling the thresher to prevent the threshed grain from accumulating on one side of the sieves when it is operated on hillsides." ***** "The level-land type is designed for use in areas where grades are not sufficient to greatly affect the performance of the machine. Hillside and many level-land types have hinged headers, the outer end of which is carried on a grain wheel," ***** "for flexibility on uneven ground. On others both the thresher and header are attached to the same frame, which is carried on wide-tread wheels. Variations also exist as to grain-handling facilities. Some machines may be obtained either with grain-bin, wagon-hitch, or grain-sacking attachment."

Some manufacturers use the rasp-bar or angle-bar cylinder instead of the spike-tooth type, and changes are constantly being made in the design of straw conveyors and cleaners." (15, p. 3)

Some of the earlier and larger combines cutting swaths from nine to twelve feet wide, could be driven at speeds of from two to three miles per hour, according to a statement in Farm Implement News. (3, p. 22)

"To meet the needs of small farms, combines in a wide variety of sizes including 7-, 8-, 9-, 10- and 12-foot cuts were placed on the market. The 7-foot size and some of the others were designed for operation from the power take-off of a tractor. One 8-foot machine was attached to and supported by a tractor. Some 10-foot and all larger sizes used an engine mounted on the combine for operating moving parts." ***** Later "the use of pneumatic tires on tractors and field machinery greatly reduced the rolling resistance of such equipment, making available a greater portion of the power developed by the tractor engine for useful work. Thus the combination of rubber tires, and the demand for combines in the Corn Belt for soybean harvesting stimulated the development of the present" (1938) "5- and 6-foot power take-off machines which can be operated by a two-plow tractor under average conditions."

"Power take-off combines mounted on rubber tires and cutting a 5- or 6-foot swath were offered to the trade for the first time in the United States in 1935. In a few cases machines were sold at an earlier date primarily for observation under farm operating conditions. During 1935 and 1936 probably 10,000 of these machines were manufactured and the greater portion of them were sold in the Corn and Winter Wheat Belts." ***** "Tests were made on 5- and 6-foot combines in harvesting small grain near Urbana, Illinois, Lafayette, Indiana, and Columbus, Ohio, and in soybeans near Urbana, and in the Mississippi Delta in the vicinity of Greenville, Mississippi and Tallulah, Louisiana. (16, p. 2)

It was found that under favorable field conditions small combines equipped with rubber tires, were operated by rubber mounted tractors at ground speeds as high as five miles per hour. (16, p. 19)

The need for a machine to "bridge the gap in the otherwise ideal harvester-thresher harvesting system" and the windrow harvesting equipment invented to care for such needs, is stated and described by Wright substantially as follows: In some sections of the country weather conditions at harvest time are often uncertain and unfavorable; a field of grain may not ripen evenly - there may be green spots of considerable area scattered through the ripened grain - necessitating a delay of several days before the grain can be successfully harvested with the combine direct from the standing stalk. In other cases the field may be very weedy, and if not cut while the weeds are still green the separation of the weed seeds and pieces of green stems and leaves from the grain is difficult. If the grain is allowed to stand until all the grain and weeds are ripe the farmer takes chances on storms and high winds, which may cause the grain to shatter or lodge, thus causing a heavy loss. To care for such conditions and possibilities the windrow-harvester and pick-up attachment were designed. This equipment is built in a number of sizes and types. "The grain when delivered by the windrow-harvester" ***** "is supported by fairly high stubble which keeps it off the ground, and permits free circulation of air underneath. In a few days of dry weather it is ripe enough for threshing." ***** "After the grain has ripened in the windrow it is picked up by a device attached to the platform of the harvester-thresher. This device delivers the grain to the platform canvas, by means of which it is delivered to the thresher, and threshed in the usual way." (34, p. 8-9)

The need for windrow-harvesters and pick-up attachments however, has lessened considerably in some areas as the combine owners have become more expert in the use of their machines, and the proper time to start them.

During 1938 a small combine was developed and tried out for 1939 volume production. This machine is the smallest in size of any yet attempted, having a 40-inch width of cut. The combine is mounted on rubber and, it is claimed, that one-plow tractor power through a power take-off provides power adequate for its operation. The threshing cylinder into which the cut crop is directly fed is 36 inches wide and 15 inches in diameter, having a possible speed range of from 425 to 1600 r. p. m. A single-unit vibrating straw rack the full width of the cylinder by 5 feet 3 1/2 inches long is provided. The cleaning shoe consists of an underblast type cleaning fan with saw tooth wind control valves, one adjustable chaffer, one adjustable sieve 22 x 29 inches, and one finishing sieve, and one steel-fingered tail rake. Either a grain bin or a sacking attachment is available as standard equipment.

In 1944 the self-propelled combine appeared in commercial production. In these combines a single engine furnishes the power for cutting and threshing, and also for moving the combine over the ground. The self-propelled one-man combine, 7 to 14 feet wide, has a front cutter bar so that fields can be opened, finished, and weed patches bypassed. As the grain is cut it is conveyed from both ends of the platform to the center, some using a canvas conveyor feed and others using an auger feed. The propelling and

supporting unit is usually an adaptation of a rubber-tired tractor. For use in rice deep-lugged tires are necessary and under exceptionally bad field conditions it is sometimes desirable to mount the combines on tracks rather than on wheels. At least five makes and nine models of self-propelled combines are being made in the United States in 1947.

The self-propelled combine is particularly worth while in custom work, when the annual use of the engine is extended over a longer period and the per acre cost is correspondingly decreased. On the other hand, the tractor-drawn combine with auxiliary engine has some advantage in heavy going, as the speed of the cutting and threshing mechanism is independent of the forward speed of the combine.

In 1944 one manufacturer of self-propelled combines obtained authorization from the Government war agencies that were directing the production of the Nation toward the war effort, to make and distribute 500 self-propelled combines to experienced, custom operators. This "Harvest Brigade" as it was called, began operations early in May in Texas and California, and by the end of the season it harvested over a million acres, or an average of over 2,000 acres per combine.

A variety of crops in addition to grain can be harvested with most of the combines made today including soybeans, rice, flax, beans, sweet clover, blue grass, and many other crops. The following table shows the production of combines in the United States according to the Industry Division, Bureau of the Census. Where available in Census reports sizes and types of combines are listed.

Combines (harvester-threshers) manufactured in the United States, 1929-1946

Year	Total No.	Pull Type			Self-propelled No.
		6 ft. and smaller	Over 6 ft. and under 12 ft.	12 ft. and larger	
		No.	No.	No.	
1929	36,957				
1930	24,409				
1931	5,907				
1932-34	<u>1</u> /				
1935	3,872				
1936	16,983				
1937	29,403	16,596	2/ 5,502	3/ 7,305	
1938	48,046	28,216	2/ 7,712	3/ 12,118	
1939	41,537	30,516	2/ 4,047	3/ 6,974	
1940	46,552	41,450	2/ 1,684	3/ 3,418	
1941	54,296	44,001	2/ 4,441	3/ 5,854	
1942	41,722	36,701	2/ 1,505	3/ 3,516	
1943	29,219	25,362	2/ 1,587	3/ 2,270	
1944	44,704	33,169	2/ 4,384	3/ 6,051	1,100
1945	51,418	39,257	3,413	5,461	3,287
1946	48,811	38,127	2,134	5,440	3,110

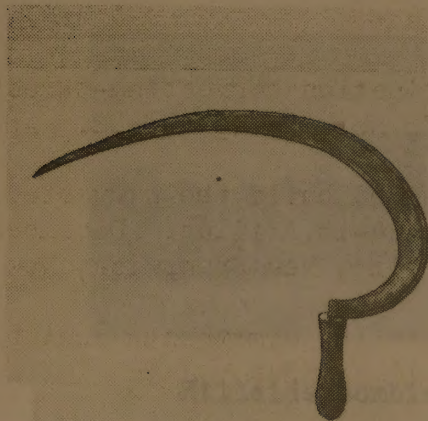
1/ Census not taken. 2/ Over 6' to and including 10'. 3/ Over 10'.

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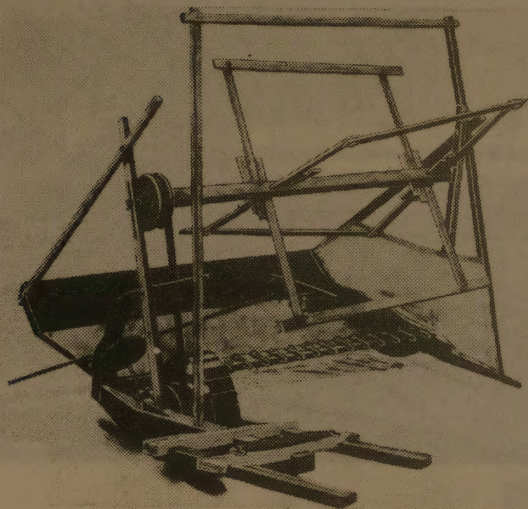
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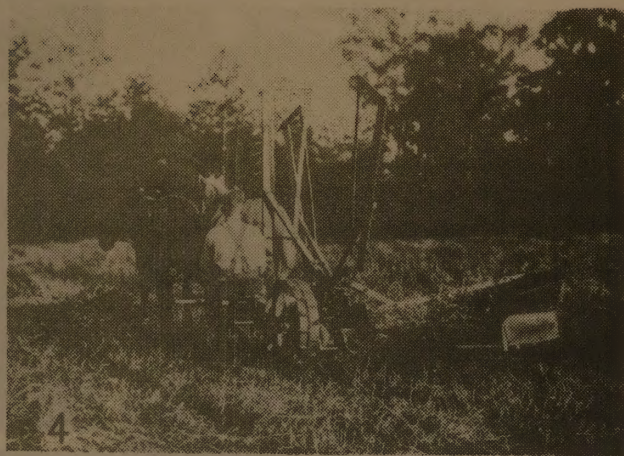
Sickle



Cradle



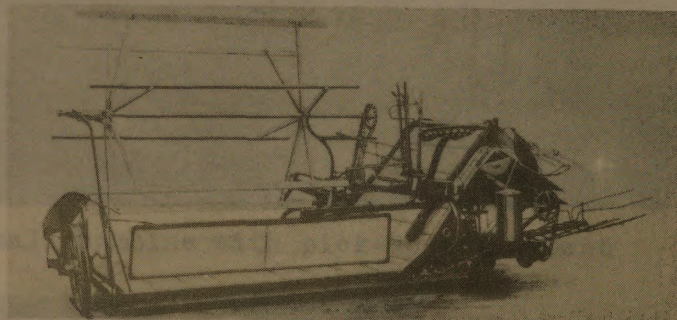
Early American reaper



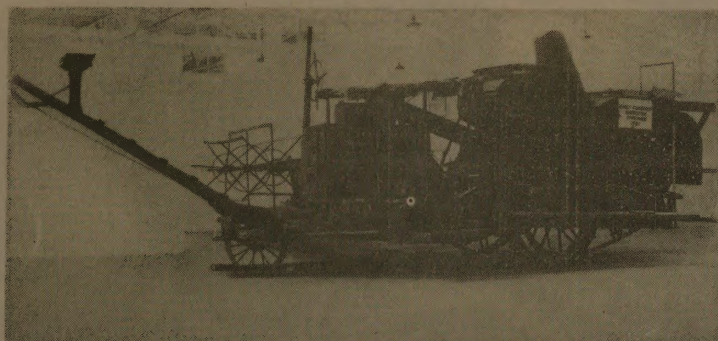
Self-rake reaper



Modern grain header



Modern grain binder



Early combined harvester-thresher



Hillside combine - horse drawn



Windrower



Small combine with pick-up attachment



Midget combine



Self-propelled combine

